THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 45. Thursday, September 17, 1931. No. 787.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial: 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2.

Telegraphic Address: "Zacatecas, Rand, London."
Telephone: Temple Bar 3951 (5 lines).

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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

SEPTEMBER 10-26.

Shipping, Engineering and Machinery Exhibition, at Olympia, London.

SEPTEMBER 12-27.

International Foundry Congress and Exhibition, at Milan.

SEPTEMBER 13-18.

Institute of Metals:—Autumn meeting at Zürich

SEPTEMBER 23.

Institute of Fuel:—Ordinary meeting in London. "The Reactivity of Coke. A Report to the Blast Furnace Committee, Iron and Steel Industrial Research Council," Paper by J. G. King and J. H. Jones.

SEPTEMBER 23-30.

British Association:—Centenary meeting in London.

SEPTEMBER 29-OCTOBER 2.

Iron and Steel Institute:—Autumn meeting at Swansea.

OCTOBER 2-10.

Coal-Face Machinery Exhibition:—To be held at the Edmund Road Drill Hall, Sheffield.

The New Foundry Education Scheme.—II.

The certificate for foundry workers will correspond with that for patternmakers, except that it is for three years only instead of four, and there is only one examination, the final, at the end of the third year. Two three-hour Papers will be set at this, one on foundry practice and science and the other on drawing and calculations for foundry workers. It cannot be too plainly stated that these examinations are for practical men who are normally getting practical experience of the trade during ordinary working hours. The questions will be practical in character and not academic, set by practical men, and will be designed to test practical knowledge and skill. The syllabus is of a very practical kind, and students who wish to see classes established should inquire of the authorities at the local evening technical institute. We feel sure that they will not make excessive demands as to the number of students necessary to form a class, in view of the specialised character of the industry. In some centres provision is already made.

To pass now to the national certificate, run in conjunction with the Institution of Mechanical Engineers, no syllabus is issued for this, because those technical schools registered for conducting national certificate courses are at liberty to frame their own syllabuses, to be approved by the Board of Education. They can thus modify the course somewhat to suit the character of the local industry, and it is here that a foundry advisory committee in each district is of great assistance.

The national certificate is essentially a professional and not a craft certificate, and is thus of a higher standard. In fact, it is intended to go up to the very highest level in the ground covered, so that the student becomes a real specialist with the highest qualification obtainable other than a university degree. It normally covers a period of study of five years, which may be extended for those with inadequate preliminary training or shortened for those otherwise situated. The national certificate, as its name implies, has a national status, and bears the endorsement of the Board of Education, the Institution of Mechanical Engineers and of the Institute of British Foundrymen. In some cases it will be possible to study for the national certificate partly in the day-time and partly in the evening, and this arrangement has much to commend it. The course will supply a sound basic knowledge of such fundamental subjects as practical mathematics, engineering drawing, mechanics and elementary science before the foundry specialisation is begun, but when this is entered on, the course will be very detailed and furnish a store of knowledge for a lifetime.

The Lesson of the Shipping Exhibition.

Elsewhere in this issue we outline the principal features of this Exhibition from the foundry owners' point of view, but there is still a wider aspect. Fortunately, the Exhibition can still be regarded as a gigantic collection of aggregations of castings, but as the years pass we cannot help but notice how competitive industries are nibbling into the province of the founder. In really heavy engineering, the founder is still holding his own, but for medium castings, if of a simple character, weldings are finding increased favour, but we are not without hope that this Exhibition will see the zenith reached. In the smaller types of castings, the craze for coloured articles has undoubtedly helped the manufacturer of non-metallic substances to further his prospect as a competitor for articles mainly for domestic or office consumption previously supplied by the foundry industry. Associated with this advantage of colour are ease of cleaning and newer design. We have had a certain amount of personal experience with these products and have found that they suffer from discoloration and warping on ageing. That this newer industry will overcome these disadvantages can and must be assumed by the foundry industry, and they on their side must create competitive material by maintaining strength; possibly reducing weight; producing attractive shapes and coloured finishes, whilst eliminating the necessity for constant cleaning.

These are not insuperable difficulties, for by a close association with the enamelling industry every objection can be met and overcome. Even lightness can be emulated. Moreover, we are not convinced that the colours produced by gum products are as bright and artistic as one finds in high-class enamelled ware. In recent years the enamelling industry has changed from a secret art to a scientific basis, and the more the founder knows about its potentialities the better it will be for both. Some day we hope to see organised a foundry-products exhibition of a technical character, designed to show industry as a whole its potentialities for meeting rigidity, strength requirements, heat and corrosion resistance, and artistic merits from shape, colour and patina angles.

The British Cast Iron Research Association.

VIII.—IMPORTANCE OF FOUNDING TO THE COMMUNITY.

Founding is even more vital to the country than is implied by the economic importance of the producing and consuming industries immediately concerned, for, with comparatively insignificant exceptions, all metals begin their existence in the cast state, and in many cases properties determined in the cast state persist in a greater or lesser degree throughout all subsequent processes of working and treatment. Furthermore, until the B.C.I.R.A. began its work, the study of cast ferrous metals had been neglected by metallurgists. The great bulk of metallurgical investigation, not only in Great Britain, but elsewhere, had been directed to the wrought metals, steels and non-ferrous metals and alloys. This in its turn was due in part to the very cheapness and university of the basic material employed, cast iron, and in part to its complexity, for metallurgically it is more complex than even the alloy steels. The economic importance of the industry may be judged from the fact that the British output of ferrous castings must normally be of the order of three million tons per annum, having a value (as castings, excluding machining or finishing costs) of about forty millions sterling, the industry employing about a quarter of a million people, of which over ten thousand are apprentices and learners. Castings represent about one-half to two-thirds of the weight (tonnage) output of the engineering industry, and, as essential parts of most machines and equipment, then enter into all public transport and other services. Castings also are widely used for domestic purposes, and in various forms are either sold directly to the public or indirectly as fittings (stoves, grates, baths, etc.) in house construction, etc. The proportion of cast iron in engineering prime movers and machines affects their weight, which is a very important factor in the export trade in machinery, as it is in other cases where transport and speed are concerned, *i.e.*, in vessels of war, in automobiles, ships, aeroplanes, etc. Careful design, for instance, with modern metallurgical knowledge, enabled the dead weight of the new German cruiser, the "Deutschland," to be reduced by 550 tons.

The Association is concerned equally with cheapening the production of cast ferrous metals and with improving their quality. Both are required to enable the material to hold its own against alternative materials (stampings, forgings, weldings, etc.), and to enable British products to compete with cast products from other industrial countries, notably U.S.A. and Germany. Although the engineering industry was born in Watt's foundry at Soho, during the past few years foundry processes and equipment have invariably been introduced into this country from abroad, where metallurgical science was originally applied to offset the economic advantage enjoyed by this country in its superior natural resources of the founding art, moulding sands, refractories, fuels, iron ores, and of skilled craftsmen. The advantages of this policy have become painfully apparent, the toll taken from the British founding industry in licence fees and royalties having steadily increased since the Armistice.

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Economics Again.

To the Editor of The Foundry Trade Journal.

Sir,—By re-reading your editorial of the 27th ultimo, your correspondent in this week's issue, Mr. Wenlock Savage, will note your argument for a reduction in the present standard of labour cost concerns wages which were raised to meet a past increased cost of living; which latter, you say, is now reduced.

May I suggest that Mr. Savage's comments could only apply if those wages had been increased for an increased output of work.

In addition to some of the cost-of-living bonuses which have been added as a permanent part of some wages, a very large increased cost has arisen in this manner: when the £1 note was worth 15s. in gold, a man who received £4 per week wages received in effect only three sovereigns' worth of gold. That three sovereigns was the true value of his work on the international market. When the Government reintroduced the gold standard, automatically they caused that same man to be paid four sovereigns' worth of gold for the same output of work. Is it to be expected that the potential foreign customers of this country will pay 33⅓ extra cost for labour brought about in this way?

It is difficult to accept Mr. Savage's other suggestion that all wages should remain disproportionately high because the output in some directions has been increased per man. Where would be the advantage to those people who are producing the greater output?—Yours, etc.,

Victor Stobie.

Dunston-on-Tyne,
September 11, 1931.

Foundry Congress at Brno.

The Czecho-Slovakian Foundrymen's Association are holding their 8th annual meeting from October 10 to 12 in Brno (Brünn). The main theme is to be the "Utilisation of National Raw Materials and Products." An exhibition, which will remain open until October 18, is designed to demonstrate the art of the founder, both ancient and modern.

The following Papers are expected to be submitted:—

(1) "Foundry Coke," by Dr. A. Altman.

(2) "Refractory Materials used in the Foundry," by Prof. Dr. J. Matejka.

(3) "Standardisation in the Foundry," by Ing. Rudolf Molak.

(4) "Foundry Blackings," by Ing. J. Cibulka.

(5) "Patternmaking," by Ing. S. Pospísil.

(6) "Raw Material for Grey Iron and Malleable," by Dr. G. Storek.

(7) "Moulding Sands," by Mr. Vladimír Uxa.

A number of works visits have been arranged, including Brno Kralova Engineering Works Company; the Ignac Storek Foundry Company; Rosice Mining Company; Brno Premier Engineering Works Company; Uxa Brothers, Limited; the Ceskomoravská-Kolben-Danek Company, and the famous boot factory of Bata, where the foundry will receive special attention.

During the conference, there is to be a reception, a banquet and a social evening, whilst a number of interesting excursions have been arranged for the ladies. A brochure on the use of domestic raw materials and products, together with three souvenir plaques, will be distributed to each delegate.

International Electricity Congress in Paris, 1932.—Under the ægis of the International Electrotechnic Commission, an International Congress is to be held in Paris next year.

Random Shots.

He who first suggested cast-iron roads, to that man be given "Marksman's" fervent blessing! Let us lay tens of thousands of miles of them, just as soon as foundries can produce by the myriad good thick solid segments of hard and close-grained iron. Them's my sentiments! For at the time of writing a battery of pneumatic road drills is going heaven for leather to reach (a kaleidoscoping head seems to tell me) the Antipodean copper mines. Perhaps there is on foot a scheme of the moment to substitute copper for iron as an *economical* road-making material; and perhaps there is not.

* * *

It seems indeed an ironical coincidence that, at a moment when a sound-proof room smacks of the Seventh Heaven, I should happen to pick up a printed note to the effect that Mr. Hiram Maxim, the inventor of the Maxim silencer, has been demonstrating in New York a device for excluding street noises from houses. This device emits a steady drone similar to that of an electric fan. Please, Mr. Printer, just go on inserting lines of asterisks while I cable Mr. Maxim—but never mind, the drills have stopped. (Thirsty work is the foreman's.)

* * *

And now, as an example of how well the mind can respond to improved working conditions, what do you say of these comments on the aeronautical event of last Sunday?

(1) As a race, it wa' Schneider one thing nor another.

(2) Fortunately no catasTrophy marred the hour of triumph.

(3) One Con't est-imate the strain imposed on man and machine. . . .

* * *

In talking of cast-iron roads, the association of ideas (or subconscious thought flow, if you will) naturally leads up to the thought of Stratford, and it was here that a policeman, giving evidence against a motor-cyclist, declared that on the back of his cycle the defendant had a "pillionaire"—a female. This is not the only contribution to etymology for which motoring is responsible. The term "autocide," meaning motoring fatalities, recently has been introduced into an American-published dictionary. There are grounds for objection to this word, however; it may be current, but for all that can be proved base coin. Thus: Fratricide, murder or murderer of a brother; matricide, murder or murderer of a mother; infanticide, murder or murderer of an infant. Therefore, autocide, murder or murderer of an auto, *i.e.*, motor-car. *Reductio ad absurdum, n'est ce pas?*

* * *

The following story is taken from Sisley Huddleston's new book, "Back to Montparnasse," and concerns Painlève, the French statesman: "Leaving home one morning to attend to his Parliamentary affairs, Painlève hung a notice on his door to the effect that he was absent but would return about midday. When he returned, he read the notice, pulled out his watch, and murmuring, 'He should be back soon,' he sat down on the stairs to await his own return."

* * *

Wisecracks.

A play is like a cigar. If it's bad it won't draw; if it's good everyone wants a box.

A Parliamentary candidate is a man who is asked to stand, wants to sit and is expected to lie.

There is no reason nowadays why a boy who clings to his mother's skirts should be a failure. He needs only to join a circus as trapeze artist.

Marksman.

Thin Films in Relation to Corrosion Problems.*

By U. R. Evans, M.A.

It is a matter of common knowledge that when a metal, such as copper or nickel, is heated gently in pure air, the surface shows a series of beautiful colours, due to the interference of light by thin oxide films on the surface. The range of film thickness which produces the bright colours may extend from about 400 A. to about 3,000 A. (1 A. = 10^{-8} cm.); the exact range naturally depends on the nature of the metal. Films thinner than about 200 A. do not cause interference of any light waves to which our eyes are sensitive; they are, therefore, invisible while in optical contact with the brightly reflecting metal, although they become perfectly visible when removed from the metallic basis. Even when they are on the metal, it is possible to detect their presence and measure their thickness by means of the very delicate optical method used in Professor Freundlich's laboratory at Berlin, and recently developed by Dr. Tronstad in Professor C. Benedick's laboratory at Stockholm. It is these ultra-thin "invisible" films which alter the chemical behaviour of the metal; the slightly thicker films responsible for the colours have often but little protective power, being too liable to cracking. Other things being equal, thick films are almost always more liable to cracking than thin ones.

For more than a hundred years, it has been known that treatment of a metal with an oxidising agent—although usually producing no change in appearance—often leaves the metal in a curious inert or "passive" condition. The opinion has long been held by some that this is due to the formation of an oxide film. There are two classes of people, however, who have never accepted this view. The one class consists of those who will never believe in the existence of anything which they cannot see with their eyes; it is possible to help this class of objectors by showing them that the films are actually visible after removal from the metal. The second class consists of those who will never accept a simple explanation if a complicated one can be suggested; it is possible to offer no help to persons of this mentality.

The Case of Copper.

The part played by protective films is shown particularly well by the work of W. H. J. Vernon on the tarnishing of copper by the sulphur compounds in the atmosphere. Vernon found that, by gently baking copper, he could increase its resistance to tarnishing. It was not necessary to use a temperature at which the baking produced interference tints; baking at a lower temperature (75 deg. C.), causing no visible change in the appearance, was sufficient to confer this remarkable immunity towards an impure atmosphere. Yet Vernon showed that the baking did produce an increase in weight which could be detected by his remarkably delicate microgravimetric method. In other words, the resistance to tarnishing was due to something which possessed weight; it was not due to annealing or to other internal change in the metal itself.

It is probable that, except for a few noble metals, such as platinum, gold and silver, most metals carry oxide on the surface, even when they are quite bright. On most metals, however, the oxide produced by the action of air is normally pervious to ions, and the metals become passive or inert only when the metal is subjected to special treatment, which brings the oxide film into a state of good repair, so that it can prevent leakage. On some materials, however, like aluminium and stainless steel, the oxide normally present has considerable protective power, and the familiar stability of these materials is entirely due to this fact. If we amalgamate aluminium with mercury, we produce a surface to which the oxide film does not adhere satisfactorily, and the attack on the aluminium under ordinary conditions becomes quite sensationally rapid. A case is on record where an aluminium vat at a brewery was completely perforated in a remarkably short space of time simply through the breakage of a small mercury thermometer. Quite strictly, we ought not to picture aluminium as a "stable" metal at all, but as a highly reactive metal which encases itself in a remarkably watertight skin of oxide. For many purposes, the natural oxide skin on aluminium is sufficient to prevent damage. On the aluminium alloys, however, the natural skin is less reliable, but it can be improved by suitable oxidising treatment. In the process of Bengough and Stuart, now widely employed on aircraft alloys, the articles are subjected to anodic treatment in a warm solution of chromic acid.

Films on Stainless Steel.

The case of "stainless steel" with 13 per cent. of chromium is rather similar. Recently the American investigators Forrest, Roetheli and Brown studied the corrosion of ordinary steel and stainless-steel specimens when rotated in water containing oxygen. It is instructive to note that when the specimens were initially in a film-free condition, both materials were at first attacked at the same velocity; but in the case of the stainless steel the velocity of attack soon died away, owing to the building up of the protective film, whilst in the case of ordinary steel, the high rate of attack persisted. There is no doubt that the resistance of stainless steel depends on its oxide skin, and here also pre-treatment with oxidising agents renders the skin yet more resistant. Hatfield, for instance, has shown that if stainless steel is immersed in dilute nitric acid, it afterwards becomes abnormally resistant to sulphuric acid.

In practically all important cases, the oxide skin has now been isolated. As early as 1920, Seligman and Williams isolated the oxide film produced on thin aluminium foil by heating at 800 deg. C. When in contact with the metal, an oxide film of this kind is normally invisible. The heated foil is indistinguishable from unheated foil when examined by reflected light in the ordinary way; but when examined by transmitted light, the heated foil is found to be quite transparent, with a number of opaque beads of unchanged metal held in place between the layers of oxide. By dissolving out this residual metal with hot nitric acid, the experimenters obtained the oxide film as a mass of colourless iridescent scales. A few years later, Liebreich and Wiederholt described an interesting experiment in which an aluminium wire was rendered passive by anodic treatment in an alkaline solution, and then, on sudden reversal of the current, the film responsible for the passivity peeled off. The method now commonly used for separating oxide films from aluminium consists in heating the specimen in a current of pure dry hydrogen chloride. This method was originally worked out by Withey and Miss Millar for the analytical estimation of oxide in aluminium at the National Physical Laboratory. The aluminium metal is converted to its chloride, which distils away, leaving the oxide unchanged. Sutton and Willstrop at the Royal Aircraft Establishment applied the principle to isolating the highly protective film produced on aluminium by the Bengough-Stuart process already mentioned. It was found possible in this way to distil away the whole of the metal from a specimen thus treated, leaving behind the oxide-skin as a thin transparent membrane.

Isolating Iron Films.

Almost all methods of isolating an oxide-skin really depend on some treatment which attacks and removes the metal whilst leaving the oxide unchanged. At Cambridge a concentrated solution of iodine in potassium iodide has been found of service for isolating the oxide-films from iron; the iodine dissolves the metallic iron as iodide, and leaves the oxide behind. This reagent can be used to separate the films from iron which has been heated in air so as to produce the interference tints commonly known as temper-colours. As would be expected, the films responsible for the later temper-colours, obtained on comparatively strong heating, are thicker and less transparent than those responsible for the early temper-colours, produced by very gentle heating. The same method will serve to isolate the "invisible" film responsible for the passivity of iron, such as may be produced by the action of a chromate solution, or even (in the case of pure iron) by exposure to dry air. This film is similar to the films responsible for the temper-colours, but it is thinner, and in general more transparent, although it contains numerous opaque spots, which are inclusions of metallic iron.

A more convenient way of isolating the oxide-skin is by means of anodic treatment. This method has been used by workers at Cambridge to isolate films from copper and nickel, as well as from pure iron, mild steel and stainless steel. In most cases it has been found possible to separate films of the ultra-thin class (invisible while on the metal), and also the rather thicker films responsible for interference colours. Usually, it is necessary to commence by grinding the surface with emery or similar abrasive. This leaves the metal near the surface in a condition in which it is specially susceptible to attack. The specimen is then subjected to such treatment as will produce the oxide-film on the surface. If it is desired to study an invisible "passivity film," the metal may be made passive by immersion in a suitable solution, such as potassium chromate; if it is desired to study a film responsible for some interference tint, the metal is heated in air or oxygen to give the appropriate colour. After the production of the film, the bottom of the specimen is trimmed, and the whole is made the anode in one limb of a U-shaped electrolytic cell containing potassium chloride solution (or, where it is desired to remove films from copper, potassium sulphate solution). The other limb contains a cathode (usually consisting of the same metal as the anode). The current flowing produces dissolution of the metal of the anode, commencing at the bottom, where the film has been cut through by the trimming. The attack extends upwards just below the film, since the portion of metal just below the film is rather specially susceptible to attack, having been affected mechanically by the original abrasion. Thus the film is undermined and loosened, and finally peels off in curling flakes, which may be washed by decantation and examined at leisure. The films preserve all the grooves and ridges produced by the original grinding; they represent the original metallic surface of the metal converted into oxide without alteration of shape.

An alternative procedure is to interrupt the process when the film is already loose but before it has peeled off, and to press the specimen on to glass covered with nitrocellulose varnish in a "tacky" condition. In this manner the film may be transferred to the glass support. Mr. John Stockdale, who has worked on this subject, carried out a number of these transfers to glass, whilst more recently Mr. S. C. Britton has succeeded in making similar transfers to cellophane. It is interesting to note that when the film from "heat-tinted" nickel is removed to glass or cellophane, it still shows colours, the tints being nearly (but not quite) complementary to those displayed when in contact with the metal.

The Thickness of Films.

It is important to note that the thicker films consist entirely of oxide, whilst the thinner films contain opaque inclusions of metal in a layer

* Tenth Autumn Lecture to the Institute of Metals.

of highly transparent oxide. In special cases, the amount of metal present in the layer which is separated is so great that the main part of the matter flaking off is opaque, with occasional transparent windows. There is ample evidence that on metal where the oxide layer is of insufficient thickness to give heat-tints there is considerable interlocking between oxide and metal. Instead of a sharp passage from a definite oxide-film to unoxidised metal, the oxide layer seems to send down roots into the metal, so that below the oxide-film proper there is a mixed zone containing both metal and oxide. The reason for this interpenetration is made quite clear by the recent work of Bowden and Rideal, who have shown that on a metallic surface—especially after abrasion—the true area vastly exceeds the apparent area, owing to the presence of cracks penetrating into the surface. Evidently oxygen may pass down these cracks, and thus produce sheaths of oxide extending down into the metal. It would be expected that the amount of oxide per unit area of the external surface will be smaller in the case of metal which has been cleaned with fine abrasive than in the case of metal which has been rubbed with coarse abrasive (although the smaller amount of oxide obtained in the first case will be the most effective in protecting the metal from corrosion, since deeply penetrating cracks are always a source of weakness). As far as it goes, the evidence confirms the expectation, but actually it is often difficult to remove the surface-layer from metal which has not been coarsely abraded previous to the oxidising treatment.

The recent optical measurements of Tronstad, however, give support to the view stated. These are, of necessity, made on metal which has been finely ground to a mirror-like surface, and the thickness of the oxide-film is considerably less than those found in the work at Cambridge. Indeed, it is possible that on a "perfect" surface the film would be only 1 molecule thick. In his delicate micro-gravimetric measurements, Vernon found that the thickness of oxide needed to protect copper from tarnishing was about 10.5 A.—the order of the molecular diameter. Likewise, the optical researches in Prof. Freundlich's laboratory indicate that the oxide-films formed by the action of air on iron mirrors (produced on glass by heating iron carbonyl vapour) are also about 10 A. thick. Considering this figure in the light of our knowledge of the size of the ferric-oxide molecules, based on the recent X-ray measurements, this thickness is not inconsistent with the idea of a monomolecular layer, although clearly the exact thickness to be expected for a layer of this character will depend on the manner in which the molecules are orientated. At all events, the formation of the much thicker layers—capable of separation—on a surface which has been abraded must depend on the fact that the abrasion produces a zone of shattered or spongy metal, capable of allowing oxygen to penetrate to a considerable depth. In view of the proved interlocking of oxide and metal and the variation of thickness from point to point, it is difficult to assign a definite value for the thickness of such oxide-films; it is quite likely that the amount of oxide present, if arranged as a uniform layer, would often be 20 molecules thick, or even more. These numbers are suggested with some reserve, for the methods at present available for measuring the thinner oxide-films are not very satisfactory. In the case of iodide-films, however, three independent methods have been worked out at Cambridge, satisfactory agreement being obtained between the three sets of results. It is hoped to extend the work to the quantitative measurement of oxide-films in the near future.

Invisible adherent oxide-films exercise a good deal of protective action on the underlying metals. It is due to this fact that the exposure of metals at ordinary temperatures to air which is reasonably dry and free from acid fumes produces no change in the appearance. The oxide-film becomes sufficiently protective to exclude oxygen molecules from the metal below before the thickness is reached at which interference tints would appear. Interference tints are produced only when the metal is heated in air to a temperature at which oxygen can diffuse through the solid oxide and attack the metal below, so that the film can reach any desired thickness if sufficient time is allowed. On the other hand, where the film-substance is porous, there is no reason why interference tints should not be produced at ordinary temperatures. Thus, silver exposed to iodine vapour at ordinary temperatures gives a wonderful sequence of tints due to iodide-films—a matter which has been the subject of much research in Germany; the recent work of Tammann deserves special mention. Two years ago, L. C. Bannister carried out a study of the production of silver iodide films by the action of a solution of iodine in chloroform on a silver surface. The velocity of the film-thickening was measured under a large number of different conditions, and the conclusion was reached that the iodide-film was sufficiently porous to transmit iodine molecules, but that it did not transmit chloroform molecules. On account of this porosity, the iodide-films will thicken rapidly at ordinary temperatures.

Colouration of Films.

Silver iodide is a very transparent substance, and, for this reason, the iodide-films show not only the early interference colours, but also the later colours. The complete sequence is given in Table I. There are five "orders," red appearing five times. Exactly the same sequence is shown by the oxide colours produced on molten lead skimmed and exposed to air. Both the silver iodide-film and lead oxide-film can be transferred from the metal on to glass or mica, and in both cases the films themselves show colours after transfer to the transparent basis. In cases where the film-substance is less transparent, the later colours are dark or absent. Thus, in the oxide colours on copper or nickel it is difficult to distinguish clearly anything beyond the third order. On iron—where the oxide-film is still less transparent—only the tints of the first order are conspicuous, although the sequence can be followed to the third order if the films are carefully prepared. In other respects the sequence of colours is in all cases the same, although on copper the natural colour of the metal modifies the tones somewhat in the earlier part of the sequence. With very transparent film-substances, optical considerations indicate that the earlier colours are likely to be weak. This is found to be the case. In examining the films of aluminium hydroxide on an aluminium basis, it was found that the first-order colours were so weak that they almost escaped notice, but the later colours were bright.

Table I.

Sequence of Colours produced by a Transparent Film on Metal.

(The Roman figure following the tint indicates the "order" of the colour.)

Yellow or Brown I	Blue II
Red-Mauve I	Green II
Blue-Mauve I	Yellow III
Blue I	Red III
Silvery "Hiatus" (or Green I)*	Green III
Yellow II	Red IV
Red II	Green IV
	Red V

* The hiatus range is silvery and practically free from colour in the case of most films on metal. In the case of air-films between glass (and also films on metal if the thickness is not uniform), a green occurs at this point. The reason for the difference is simply the breadth of the absorption bands. Clearly if the first band has passed out at the red end of the visible spectrum before the second band enters the violet end, one may expect a range of thickness at which there will be no colour. With broader bands, the second will enter the violet before the first has left the red, and there will be a green colour at this range of thickness.

The sequence of tints produced by copper sulphide films, obtained by the action of air containing hydrogen sulphide on copper at ordinary temperatures, is identical with the sequence due to copper oxide films obtained by the action of pure air at high temperatures. Evidently the copper sulphide, like the silver iodide film, is permeable at ordinary temperatures. Vernon has shown that the presence of an oxide-film on copper interferes with the attack on the metal by sulphur compounds. Thus copper first exposed to pure air resists tarnishing on subsequent exposure to sulphurous air. On the other hand, if a small trace of sulphur compounds is present in the air from the first, the film substance is sufficiently porous for its growth to continue. The tarnish-film thus produced consists of oxide as well as sulphide.

In resisting the more complicated forms of corrosion, protective films play a large part. The effect of small quantities of alloying constituents here requires consideration. The idea that a "pure" metal is necessarily more resistant than the same metal containing small amounts of other constituents is inconsistent with the facts. Certain additions—especially of metals which enter into solid solution—may definitely add to the resistance of a metal. Sometimes they modify the primary film; more often they ensure that the film shall be of a self-repairing character, so that if the film is locally damaged by scratching or bending, the corrosion-product produced at a weak point shall be of a nature suited to repair the damage. On the other hand, certain other additions, especially those which cause a second phase to appear in the material, increase greatly the liability of the film to breakdown. Thus, in a study of anodes for use in chromium plating, a recent research by Baker and Pettibone at the University of Michigan has shown that the dissolution of steel anodes in the chromic acid liquid became smaller as the carbon content of the steel was reduced, whilst electrolytic iron was dissolved less than any steel. These facts point to a breakdown of the film at the junction between carbide and ferrite grains. The results cannot be explained merely by postulating an e.m.f. between carbide and ferrite grains—an explanation so often suggested in discussing the different behaviour of steel and pure iron—for in chromium plating an e.m.f. is applied from an external source which, even in the absence of carbide, would be sufficient to cause rapid dissolution of the metal but for the existence of a film over the surface.

Even where the total attack on pure material is less than on impure, it must not be assumed that pure material is superior for all purposes. For if corrosion is to occur at all, it is better that it shall spread out and become general rather than that it shall remain localised. Under some conditions, therefore, a second phase may here be actually helpful. Certain waters, under conditions of agitation, produce general corrosion on steel, and intense localised attack (pitting) on pure iron, which leads more rapidly to perforation than the general attack.

In practice, the demand that a film shall be self-healing is of the utmost importance. Recent work—especially the electrochemical work of Britton on aluminium—suggests that breakdown may occur quite suddenly and spontaneously in a protective film, but the fissure may heal up again almost equally quickly if the conditions are favourable. The same idea was suggested by Vernon's micro-gravimetric work on aluminium, published many years ago. Whether these breakdowns are truly spontaneous, or are due to internal stresses in the metals, does not greatly matter; for under service conditions the film is liable occasionally to suffer damage due to external causes, such as scratching or bending, or perhaps by the impingement of air bubbles, as suggested by the important researches of Bengough and May on brass condenser tubes. It is essential that any corrosion which commences at a fault in the film should give rise to corrosion product in a form which will repair the damage. May's experiments have demonstrated a notable difference in this respect between

(*Continued on page* 184.)

Mechanical Properties of Malleable Iron on Various Sized Test-Bars.*

By A. L. Norbury, D.Sc. (British Cast Iron Research Association, Birmingham).

Synopsis.

The present Paper contains an account of transverse, tensile, bend and elongation tests carried out on round and oblong test-bars of various sizes of blackheart malleable and of whiteheart malleable, after one, two and three anneals and with increased manganese content. Photomicrographs of the ¼-in. and ½-in. round bars from edge to centre are shown for each of the above types of malleable, and the variations in mechanical properties with size of test-bars are related to the microstructure. In the case of blackheart, as the size of test-bar increases the transverse strength increases very considerably, while the bend decreases. In the case of whiteheart, as the size of test-bar increases the strength increases, and then decreases while the ductility progressively decreases. With increase in number of anneals of whiteheart the ductility progressively increases, while the strength varies in a complicated manner, increasing on certain sizes of test-bar and decreasing on others. Increasing the manganese content of whiteheart from 0.08 to 0.56 per cent. is shown to have a remarkable effect in increasing the strength and ductility of all except the smallest sized bars. In nearly all cases the round bars give better strength and ductility figures than oblong bars of similar size. The problem of standard test-bars for malleable iron is discussed, and it is suggested that round tensile bars 0.253, 0.564 and 0.977 in. dia. would be suitable, the two smaller for whiteheart and the two larger for blackheart.

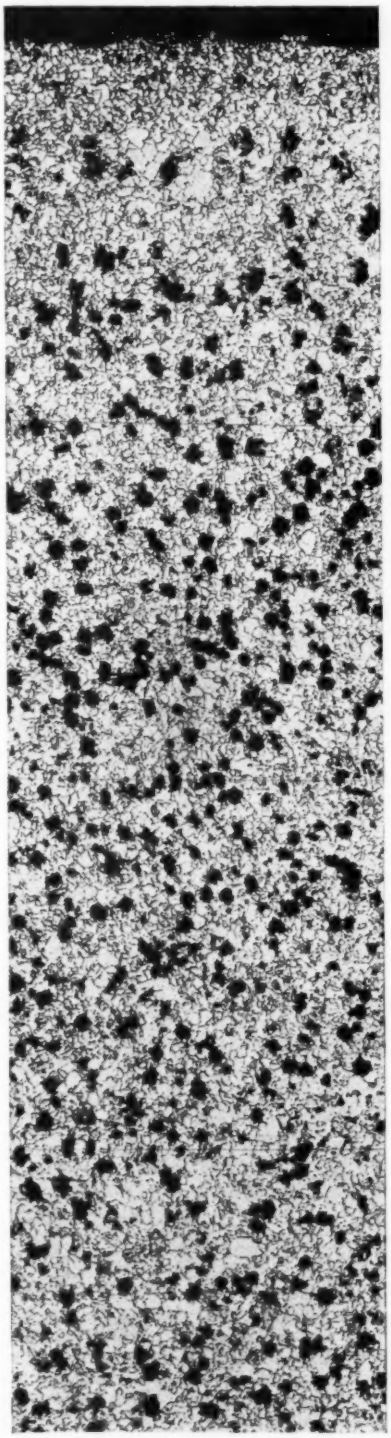


FIG. A.—0.25-IN. DIA. BLACKHEART. EDGE TO CENTRE. × 35.

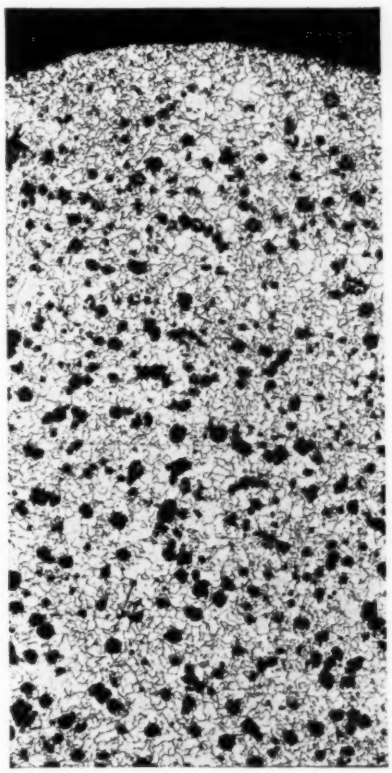


FIG. B.—0.564-IN. DIA. BLACKHEART. EDGE TO CENTRE. × 35.

Tests Carried Out.

The following types of malleable cast iron were tested:—(*a*) Blackheart; (*b*) whiteheart, after one anneal; (*c*) whiteheart, after two anneals; (*d*) whiteheart, after three anneals; and (*e*) whiteheart, with manganese content increased from 0.08 to 0.56 per cent. (The analyses and annealing conditions are given in Table I.)

On each of the above types the following mechanical tests were carried out:—(*a*) Transverse strength (on 6-in. centres); (*b*) bend (round 1-in. radius); (*c*) tensile strength; (*d*) elongation (on 2 or 1 in., see Tables II and III), and (*e*) yield point. (The results of the above tests are plotted in Figs. 2-25, and given in Tables II and III.)

The above tests were carried out on round bars of various diameters between ⅛ in. and 1 in. dia., and on oblong bars ¾ in. or 1 in. wide,

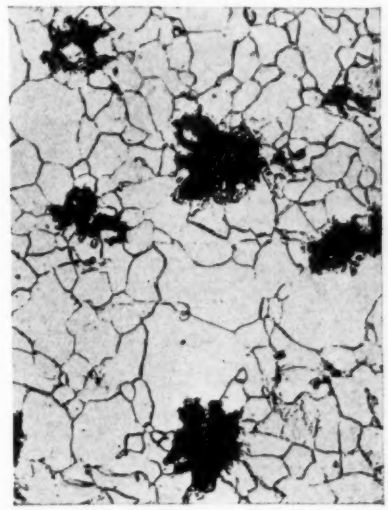
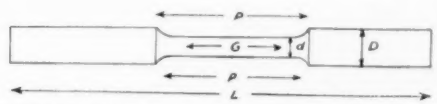


FIG. C.—0.564-IN. DIA. BLACKHEART. CENTRE OF BAR SHOWN IN FIG. B. × 200.

and of various thicknesses between $\frac{1}{16}$ in. and ¾ in. (The dimensions are shown in detail in Fig. 1.)

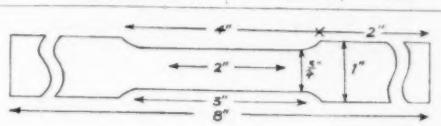
Photomicrographs of each of the above types of malleable iron are given (in Figs. A to O), showing:—(*a*) The 0.25-in. dia. round tensile bar from edge to centre (at 35 dia. magnifica-



Round Tensile Bars (dimensions in inches).

d	G	P	p
0.977	3.5	4.0	5.0
0.798	3.0	3.375	4.0
0.564	2.0	2.25	3.0
0.358	1.25	1.50	2.0
0.253	0.9	1.15	1.5
0.126	0.5	1.0	1.25

L	D	Area	$\sqrt{\text{Area}}$
		sq. in.	in.
9.0	1.25	0.75	0.87
8.0	1.0	0.5	0.71
7.0	0.75	0.25	0.50
6.0	0.5	0.1	0.32
5.5	0.375	0.05	0.22
5.25	0.2	0.0125	0.11



Oblong Tensile Bars of the dimensions shown above and the following thicknesses:—$\frac{1}{16}$ in., ⅛ in., ¼ in., ½ in., ¾ in.

Round Transverse Bars.—8 in. long and ⅛ in., ¼ in., ½ in., ¾ in. and 1 in. dia.

Oblong Transverse Bars.—8 in. long, 1 in. wide and $\frac{1}{16}$ in., ⅛ in., ¼ in., ½ in. and ¾ in. thick.

FIG 1.—SIZES OF MALLEABLE IRON TENSILE AND TRANSVERSE TEST-BARS.

* A Paper presented to the Pan-European Foundry Congress (Milan) on behalf of the Institute of British Foundrymen.

tion); (*b*) the 0.564-in. dia. round tensile bar from edge to centre (at 35 dia. magnification), and (*c*) the centre of the 0.564-in. dia. bar (at 200 dia. magnification).

The blackheart bars were cast from iron melted in a Heroult electric furnace, the whiteheart from cupola metal. The whiteheart with increased manganese content was made by adding 80 per cent. ferro-manganese to the ladle.

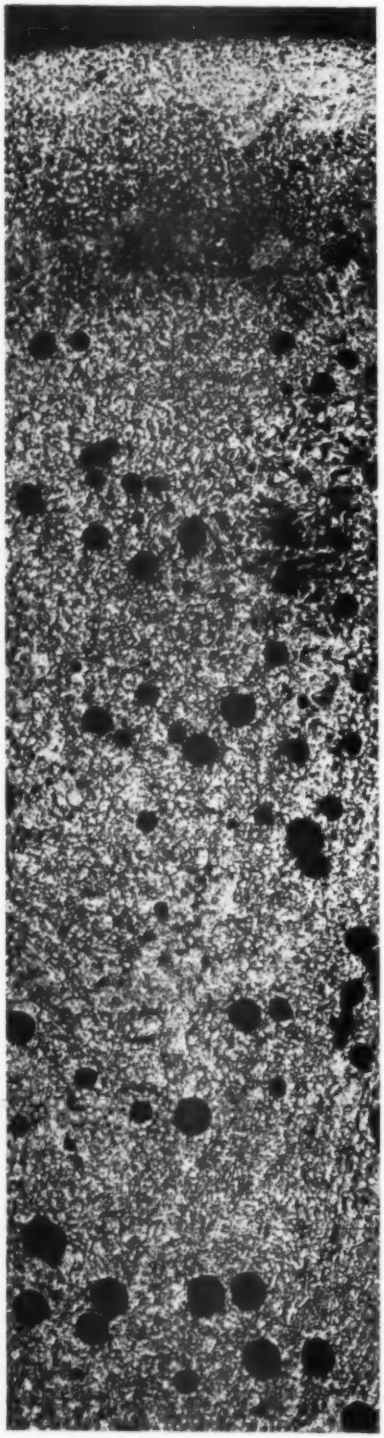


Fig. D.—0.25-in. dia. Whiteheart. One Anneal. Edge to Centre. × 35.

The whiteheart malleable irons tested had high total carbon contents of 3.84 and 3.64 per cent., and were being used in the manufacture of thin work, such as buckles, etc. Considerably higher mechanical properties can be obtained on whiteheart having a lower total carbon content in the as-cast condition.

The bars were cast in green sand and were run slightly uphill from a common runner. The bars were annealed under commercial conditions and were then sand-blasted and tested without machining.

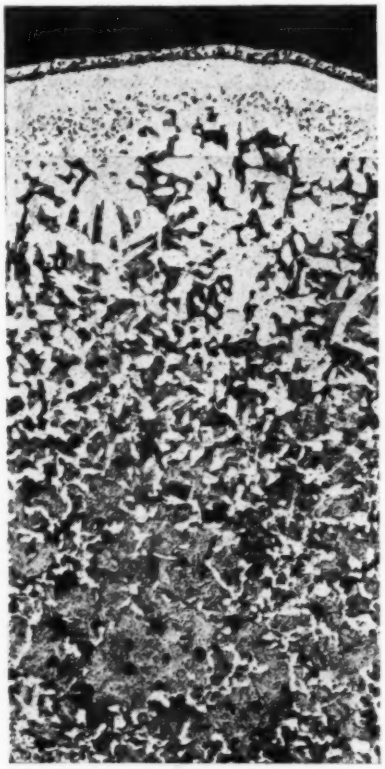


Fig. E.—0.564-in. dia. Whiteheart. One Anneal. Edge to Centre. × 35.

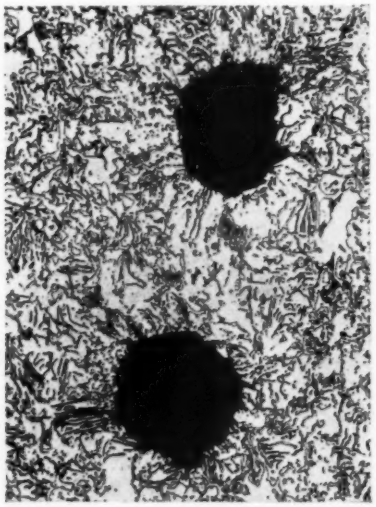


Fig. F.—0.564-in. dia. Whiteheart. One Anneal. Centre of Bar shown in Fig. E. × 200.

Table I.—*Analyses (Before Annealing) and Time and Temperature of Annealing of Malleable Cast Iron Test-Bars.*

	Cast No.	T.C. Per cent.	Si. Per cent.	Mn. Per cent.	S. Per cent.	P. Per cent.	Time and Temp. of Annealing.
Blackheart	1	2.40	1.32	0.31	—	0.146	120 hrs. at 870 deg. –880 deg. C.
	2	2.35	1.36	0.28	—	0.146	do.
	3	2.40	1.41	0.24	—	0.114	do.
	4	2.50	1.25	0.24	—	0.158	do.
	5	2.43	1.27	0.21	—	0.154	do.
Whiteheart after 1, 2 and 3 anneals	6	3.84	0.49	0.10	0.230	0.079	120 hrs. at 900 deg. –1,000 deg. C.
	7	3.84	0.49	0.10	0.230	0.079	2 anneals as above.
	8	3.84	0.49	0.10	0.230	0.079	3 anneals as above.
Whiteheart with 0.08 and 0.57 per cent. Mn.	9	3.64	0.49	0.08	0.216	0.064	120 hrs. at 900 deg. –1,000 deg. C.
	10	3.64	0.49	0.08	0.216	0.064	do.
	11	3.64	0.49	0.57	0.216	0.064	do.

Microstructures of Irons Tested.

It is convenient to consider first the photomicrographs shown in Figs. A to O, before considering the results of the mechanical tests, since the variations in mechanical properties with size of test-bar are extremely complicated, and can only be explained in terms of the variations in the microstructures of the test-bars. It would be desirable to show photomicrographs of every round and oblong bar from edge to centre and at different magnifications. As this is not possible, the microstructures of the other sized bars have to be inferred from the illustrations shown. Generally speaking, the outer portions of the larger sized bars tended to have microstructures similar to the inner portions of the smaller sized bars. Similarly, comparing round and oblong bars, the microstructure tended in the case of an oblong bar having a thickness equal to the round bar's diameter, to be similar at equal distances from the outside in each case.

Fig. A. 0.25-in. dia. Blackheart. Edge to Centre.—The structure consists of temper-carbon nodules in a matrix of ferrite grains. In the centre the temper-carbon nodules are about 0.12 mm. apart and the ferrite grains are about 0.02 mm. in dia. There is no appreciable variation in structure from edge to centre. Near the edge the bar has had the graphite oxidised out, and at the extreme edge the ferrite grains have oxide at the crystal boundaries.

Fig. B. 0.564-in. dia. Blackheart. Edge to Centre.—The structure is similar to that of the smaller sized bar shown in Fig. A, with the exception that the temper-carbon nodules are somewhat larger and farther apart. (The graphite content is approximately the same as that in the 0.25-in. bar, since very little decarbonisation, except at the outside, occurs in the blackheart anneal.) The temper-carbon nodules are about 0.15 mm. apart. The ferrite grains are about 0.02 mm. in dia. and consequently similar in size to those in Fig. A.

Fig. C. 0.564-in. dia. Blackheart. Centre of Bar shown in Fig. B.—The ferrite grains and temper-carbon nodules are shown at a higher

magnification. Traces of carbide are visible at the crystal boundaries.

Fig. D. 0.25-*in. dia. Whiteheart. One Anneal. Edge to Centre.*—At the centre the structure contains temper-carbon nodules which are more compact, much fewer in number, and much farther apart than those in the blackheart shown in Fig. A. The matrix is pearlite and ferrite in a relatively coarse form (compare Fig. G). Towards the edge the temper-carbon nodules decrease in size and finally disappear, and the pearlite-ferrite contains increasing amounts of ferrite. Surrounding the coarse pearlite-ferrite there is a ring of fine pearlite-ferrite, whose formation is discussed later in connection with the structure shown in Fig. G. Outside this there is a ring of ferrite containing dots of iron sulphide. Outside this there is a fringe of pearlite (also visible in Figs. G, J, K, M, N, and also present although not shown in the photomicrographs in Figs. E and H), and outside this, at the extreme edge, oxides and silicates are visible under a higher magnification, and occur chiefly at the crystal boundaries. The rings of oxidised iron and pearlite are formed during cooling, since at certain temperatures during cooling the atmosphere in a whiteheart annealing oven becomes carburising and at lower temperatures oxidising.

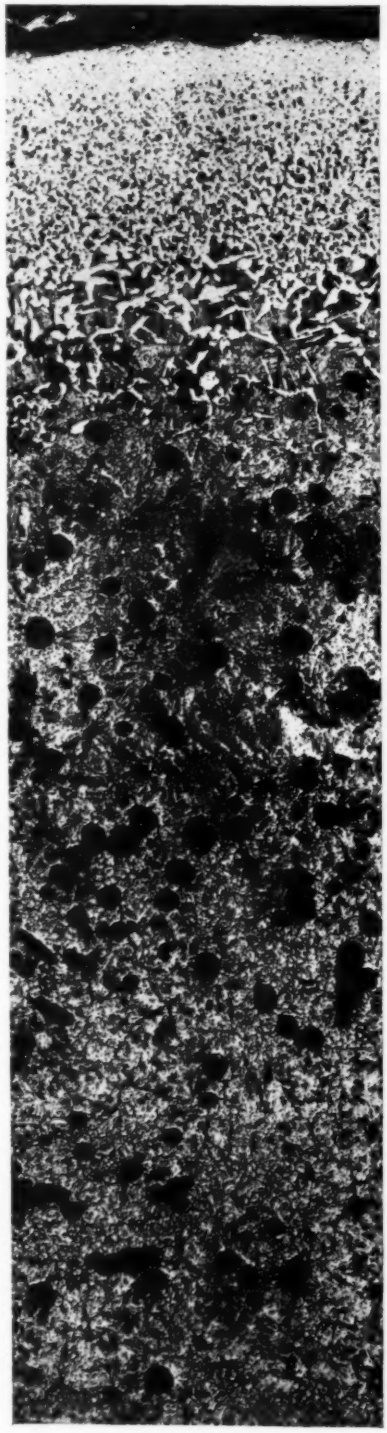


FIG. G.—0.25-IN. DIA. WHITEHEART. TWO ANNEALS. EDGE TO CENTRE. × 35.

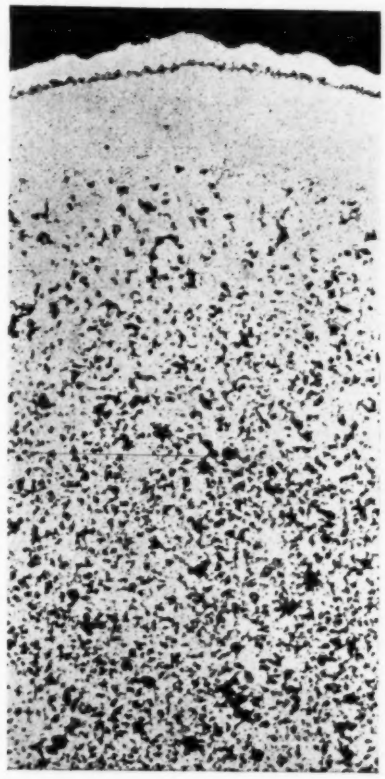


FIG. H.—0.564-IN. DIA. WHITEHEART. TWO ANNEALS. EDGE TO CENTRE. × 35.

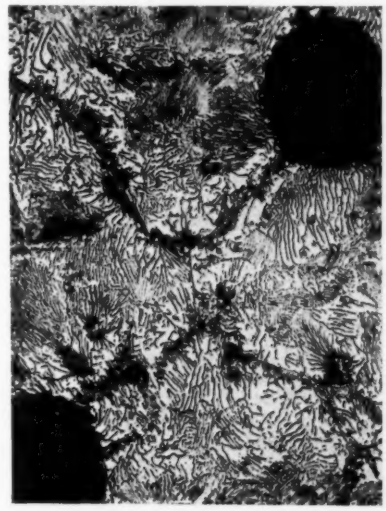


FIG. I.—0.564-IN. DIA. WHITEHEART. TWO ANNEALS. CENTRE OF BAR SHOWN IN FIG. H. × 200.

Fig. E. 0.564-*in. dia. Whiteheart. One Anneal. Edge to Centre.*—At the centre the structure consists of temper-carbon nodules, lakes of undecomposed white iron (see Fig. F), secondary cementite and pearlite. From centre to edge the lakes of undecomposed white iron decrease in size and finally disappear. Beyond this point the secondary cementite progressively disappears. Beyond this the pearlite progressively disappears, giving place to fine pearlite-ferrite as before.

Fig. F. 0.564-*in. dia. Whiteheart. One Anneal. Centre of Bar shown in Fig. E.*—Two

TABLE II.—*Transverse, Bend and Tensile Tests on Round Bars of Malleable Cast Iron.*

Cast number.		1	2	3	4	5	6	7	8	9	10	11
		Blackheart.					Whiteheart.			Whiteheart.		
							No. of Anneals.					
	Test-bar dia. In.	Normal anneal.					1	2	3	0.08 per cent. Mn.		0.57 per cent. Mn.
Transverse strength	1.0	58	48	61	56	65	53	31	33	44	49	60
	0.75	56	56	57	57	—	46	52	46	49	35	58
	0.5	52	44	54	51	49	42	60	50	51	46	57
(Tons per sq. in.)	0.25	—	—	33	41	39	22	39	36	29	23	30
Bend (in degrees)	1.0	43	22	53	30	45	2	3	5	6	4	12
	0.75	135	35	86	52	—	7	9	8	9	8	16
	0.5	>180	35	151	44	80	12	34	35	29	18	24
	0.25	—	10	31	>180	62	154	175	180	16	>180	>180
Tensile strength (Tons per sq. in.)	0.977	—	22	20	18	24	17	17	14	15	13	14
	0.798	24	23	23	23	23	17	17	16	21	21	26
	0.564	23	25	25	25	—	27	23	9	20	20	27
	0.358	23	26	24	24	—	30	25	7	22	17	24
	0.253	—	27	26	27	—	26	23	—	21	19	20
	0.126	—	—	—	—	—	—	—	—	22	21	20
Elongation Per cent. on 2 in.	0.977	—	9	6	3	10	0	0	0	1	1	1
	0.798	15	9	15	12	10	0	1	0	2	2	3
	0.564	9	16	12	20	—	0	1	3	2	2	3
on 1 in.	0.358	19	20	17	7	—	4	5	10	10	3	5
	0.253	—	27	18	18	—	7	12	—	15	13	12
	0.126	—	—	—	—	—	—	—	—	—	—	10
Yield point ..	0.977	—	16	16	17	17	—	—	—	15	13	14
	0.798	16	17	17	17	17	—	—	—	18	14	19
(Tons per sq. in.)	0.564	17	18	18	18	—	—	—	—	18	19	18
	0.358	17	19	18	17	—	—	—	—	12	12	18
	0.253	—	19	19	16	—	—	—	—	14	12	13
	0.126	—	—	—	—	—	—	—	—	14	—	—

nodules of temper-carbon are shown, also lakes of undecomposed white iron and pearlite. The secondary cementite has been deposited on the lakes of white iron, and is consequently not present in the centipede-like form shown in Fig. I. The cementite in the pearlite also has

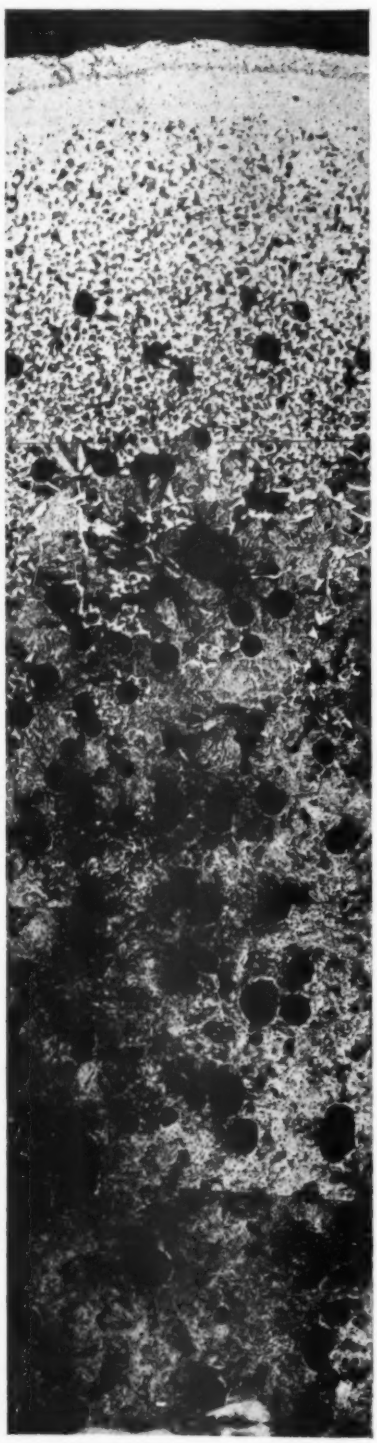


Fig. J.—0.25-in. dia. Whiteheart. Three Anneals. Edge to Centre. × 35.

been deposited to a considerable extent on the numerous white iron lakes. The typical thumb-print structure of the pearlite is consequently somewhat broken up. Iron sulphide crystals are also present.

Fig. G. 0.25-*in. dia. Whiteheart. Two Anneals. Edge to Centre.*—The structure differs from that shown in Fig. D of the same sized bar after the first anneal, in that the temper-carbon nodules are smaller, the pearlite-ferrite structure is much finer, and the ferrite band extends farther inwards. While Fig. 6 shows only the fine type of pearlite-ferrite, Fig. D (and incidentally Figs. E, H, K and N) show both the

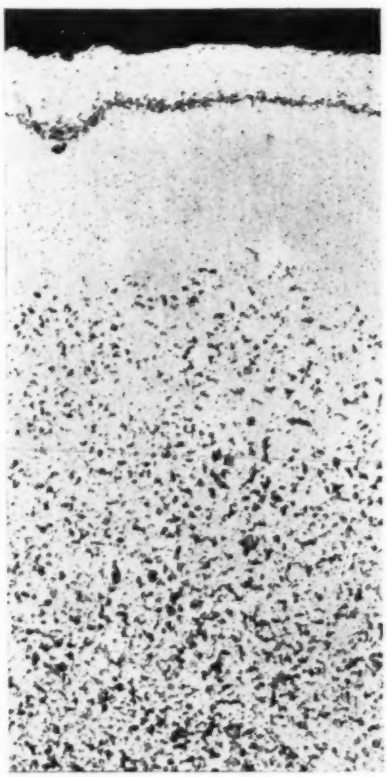


Fig. K.—0.564-in. dia. Whiteheart. Three Anneals. Edge to Centre. × 35.

coarse and the fine types. It is suggested that the coarse type results from crystal growth due to carbide from the white iron diffusing from the centre towards the outside to replace carbon lost by decarbonisation. The finer type, it is suggested, is formed after practically all the carbide from the white iron has diffused out and when the graphite nodules commence to dissolve, and that this latter process breaks up to crystal structure. The fine form gives much greater strength than the coarse.

Fig. H. 0.564-*in. dia. Whiteheart. Two*

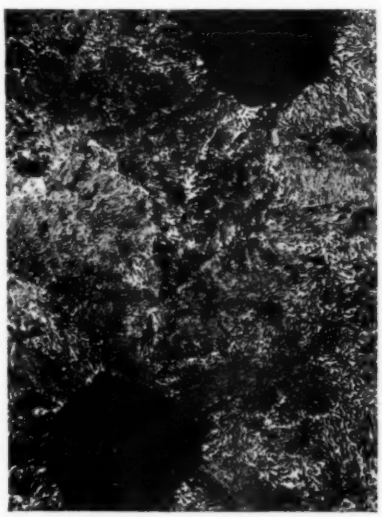


Fig. L.—0.564-in. dia. Whiteheart. Three Anneals. Centre of Bar shown in Fig. K. × 200.

Anneals. Edge to Centre.—At the centre the structure consists of temper-carbon nodules, secondary cementite in the centipede-like streaks (see Fig. I) and pearlite. No undecomposed white iron is now present; some of it has probably decomposed into graphite and the remainder diffused towards the outside to replace carbon removed by decarbonisation. From centre to edge the secondary cementite decreases in amount and disappears at about half-way. Beyond this the pearlite decreases and gives place to coarse and then fine pearlite-ferrite. The graphite nodules disappear at about the same distance from the edge as those in Fig. E, in spite of the much greater amount of decarbonisation.

Fig. I. 0.564-*in. dia. Whiteheart. Two*

Table III.—*Transverse, Bend and Tensile Tests on Oblong Bars of Malleable Cast Iron.*

Cast number.		1	2	3	4	5	6	7	8	9	10	11
	Test-bar thick-ness. In.	Blackheart. Normal anneal.					Whiteheart. Number of anneals.			Whiteheart. 0.08 per cent. Mn.		+ 0.57 per cent. Mn.
							1	2	3			
Transverse strength (tons per sq. in.).	0.75	49	48	48	51	50	28	31	33	39	37	30
	0.5	46	46	47	48	—	32	36	33	35	38	44
	0.25	34	34	40	40	—	38	38	37	34	37	38
	0.125	—	35	—	36	—	37	38	22	23	21	20
	0.06	—	18	30	30	—	—	—	—	—	—	—
Bend (in degrees).	0.75	43	30	35	55	32	5	4	8	6	7	4
	0.5	65	60	132	68	—	8	11	10	10	12	18
	0.25	—	36	155	136	—	20	55	60	73	115	75
	0.125	50	>180	—	160	—	27	180	180	>180	168	>180
	0.06	—	45	85	>180	—	—	—	—	100	—	170
Tensile strength (tons per sq. in.).	0.75	24	20	23	22	22	15	17	13	—	—	—
	0.5	23	25	24	25	—	20	19	18	20	20	26
	0.25	—	17	20	19	24	20	20	—	18	19	18
	0.125	18	18	16	23	17	16	20	—	16	14	15
Elongation (per cent. on 2 in.).	0.75	14	8	13	8	8	0	0	0	—	—	—
	0.5	15	12	14	15	—	1	1	3	1	1	4
	0.25	—	3	7	6	11	5	5	—	4	6	5
	0.125	2	0	2	5	3	2	6	—	9	8	6
Yield point (tons per sq. in.).	0.75	—	—	—	—	—	—	—	—	—	—	—
	0.5	16	17	17	18	—	—	—	—	18	17	19
	0.25	—	16	17	16	17	—	—	—	11	11	11
	0.125	16	18	16	17	16	—	—	—	9	9	9

Anneals. Centre of Bar shown in Fig. H.—Two nodules of temper-carbon are shown. No lakes of white iron are present, consequently the secondary cementite has supercooled[1] somewhat owing to the absence of white-iron carbide particles or "nuclei" out of solution to initiate crystallisation. It has consequently been deposited in a finer form than in Fig. F, at the same temperature as the pearlite, that is to say, at the temperature of the allotropic transformation, hence its form of centipede-like streaks. Iron sulphide particles are also present as before.

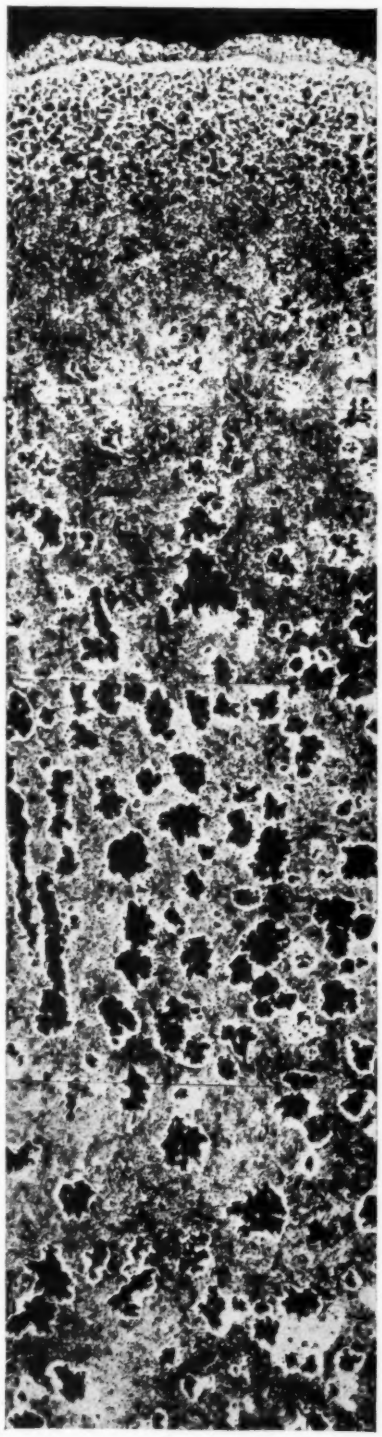


FIG. M.—0.25-IN. DIA. WHITEHEART. ONE ANNEAL. CONTAINING 0.57 PER CENT. MANGANESE. EDGE TO CENTRE. × 35.

Fig. J. 0.25-*in. dia. Whiteheart. Three Anneals. Edge to Centre.*—The structure is similar to that shown in Fig. G of the same sized bar after the second anneal, except that the temper-carbon nodules are smaller and disappear farther from the edge, also the ferrite band is deeper.

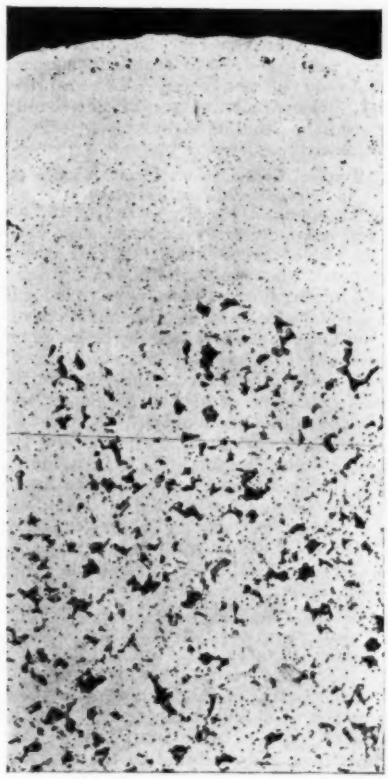


FIG. N.—0.564-IN. DIA. WHITEHEART. ONE ANNEAL. CONTAINING 0.57 PER CENT. MANGANESE. EDGE TO CENTRE. × 35.

Fig. K. 0.564-*in. dia. Whiteheart. Three Anneals. Edge to Centre.*—At the centre the structure consists of pearlite (see Fig. L). No secondary cementite is present, carbide having diffused towards the outside to replace carbon removed by decarbonisation. From centre to edge the pearlite is progressively replaced by coarse pearlite-ferrite and then by fine pearlite-ferrite. In this photomicrograph, ferrite is present as far in as halfway between edge and centre. The graphite nodules have not appreciably altered in size except those nearest the edge; in the fine pearlite-ferrite structure, which are smaller; they disappear, however, at about the same distance from the edge as those in Figs. E and H. It appears that under the conditions of the whiteheart malleable anneal the white iron nearest the edge is removed by decarbonisation before any graphite is deposited from it; farther inside graphite nodules form but dissolve in the matrix as soon as the carbide from the white iron has been reduced by diffusion to the outside to a sufficiently low figure. This solution of the graphite produces the fine form of pearlite-ferrite on cooling as suggested when discussing Fig. G. Farther away from the outside, however, the carbon content of the solid solution surrounding the graphite nodules is kept up by the relatively rapid diffusion of carbide from the interior, to a figure sufficiently high and near to saturation to prevent the graphite nodules from dissolving.

Fig. L. 0.564-*in. dia. Whiteheart. Three Anneals. Centre of Bar shown in Fig. K.*—Two nodules of temper-carbon are shown. No secondary cementite is present, consequently the pearlite has supercooled slightly and is finer than that shown in Fig. I.

Fig. M. 0.25-*in. dia. Whiteheart. One Anneal, containing* 0.57 *per cent. Manganese. Edge to Centre.*—This material differs from that shown in Fig. D only in respect of its manganese content, having been raised from 0.08 to 0.57 per cent., and its total carbon content in the white-iron condition being 3.64 instead of 3.84 per cent. The temper-carbon in Fig. M has all dissolved (probably owing to its less compact form, see Figs. N and O, and owing to the slightly lower total-carbon content of the white iron), and has, together with the carbide originally present, nearly all been removed by diffusion, etc. Only small amounts of pearlite are left in the centre. The small amounts of carbide present have been deposited in many cases in the form of streaks of carbide at the crystal boundaries. Particles of sulphide are visible as dots throughout the photomicrograph. Under a higher magnification the sulphide particles away from the edge had the slate-blue colour of manganese sulphide, but those nearer the edge had the yellow colour of iron sulphide. The explanation appears to be that near the edge the managnese became oxidised, and the sulphur that was combined with it formed iron sulphide.

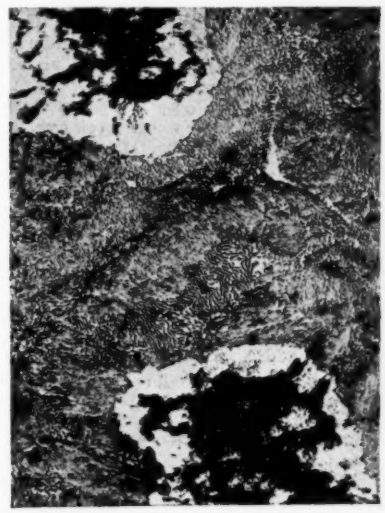


FIG. O.—0.564-IN. DIA. WHITEHEART. ONE ANNEAL. CONTAINING 0.57 PER CENT. MANGANESE. CENTRE OF BAR SHOWN IN FIG. N. × 200.

Fig. N. 0.564-*in. Whitehcart. One Anneal, containing* 0.57 *per cent. Manganese. Edge to Centre.*—This material again only differs from that shown in Fig. E in respect of its manganese content having been raised from 0.08 to 0.57 per cent. and in respect of its total-carbon content. This raising of the manganese content has neutralised[2] the carbide stabilising action of the 0.216 per cent. sulphur present. The net effect is that the lakes of white iron shown in Figs. E and F have in Figs. N and O decomposed into temper-carbon. The temper-carbon nodules in Fig. N are much more numerous, and of a different and less compact form than those in Fig. E. (This ragged form of temper-carbon can also be obtained in the 0.08 per cent. manganese type of whiteheart by raising the silicon content.) The neutralising of the sulphur, in addition to allowing the white iron to graphitise, has caused the secondary cementite to graphitise on cooling, and even caused some of the carbon in solid solution surrounding the temper-carbon

(*Continued on page* 182.)

[1] This explanation was suggested by the author in "Constitutional Diagrams for Cast Irons and Quenched Steels," J.I.S.I., Vol. 119. No. 1, Page 461.

[2] This neutralising action of manganese on sulphur is referred to by: F. H. Hurren, "Malleable Iron," "I.B.F. Proceedings," Vol. 21 (1927-1928), Page 586. A. L. Norbury, "Influence of Manganese in Cast Iron," "I.B.F. Proceedings," Vol. 22 (1928-1929), Page 151. R. Stotz, "Die Giesserei," Vol. 16, September 6, 1929, Page 839.

The German Foundry Employers' Federation.

SIXTY-FIRST ANNUAL MEETING.

FIRST DAY.

This year's general meeting of the German Foundry Employers' Federation, Düsseldorf, was held in Berlin on September 3 and 4, under the chairmanship of its new President (Baron von Wittgenstein), and was attended by representatives of polytechnics and mining colleges, allied associations and the Press. In view of the further deterioration in the economic position, the meeting had again been organised on the basis of a working programme pure and simple, and the members, who had come from all parts of Germany, united in the serious tackling of vital economic problems and in emphasising the need of holding together.

Thursday, September 3, after a meeting of the chief advisory council of the Association, was devoted to addresses on technical subjects. Herr Blotenberg, Dipl. Eng., Düsseldorf, spoke on "Transport Problems in Iron Foundries." Then followed a Paper by Herr Osann, jun., Dr. Eng., Duisburg-Hamborn, on "Metallurgical Contributions to Our Knowledge of Cupola-Melting Processes." Finally, Prof. Piwowarsky, Aix-la-Chapelle, spoke on "A New High-Grade Pig-Iron for Foundry Purposes." The addresses were followed with lively interest and, in view of the actuality of the subjects, gave rise to an exhaustive discussion.

Transport Problems in Iron Foundries.

The importance of the transport question as shown by the relative proportion of transport costs to production costs was the subject of Herr Blotenberg's Paper. In some works, it was pointed out, the former may amount to as much as 30 per cent. of the latter. Transport costs are affected, not only by the actual transport media, but also by structural conditions. By improvements in the transport arrangements it is possible in some cases to effect a substantial reduction in the figure mentioned, especially as the placing of the works on a more economic basis in respect of transport does not invariably or necessarily mean the provision of expensive plant. For, in many cases, it is possible to reduce expenses simply by drawing up suitable schemes for working and for transport. The preparation of such schemes necessitates a large amount of spade work and organising ability. The transport media hitherto in commonest use, as narrow-gauge tracks, travelling crane, overhead runway, etc., have now been supplemented by electric trollies and telphers. The telpher has proved its worth, not only in large works, but more particularly in small foundries. It expedites loading and unloading, and by the use of stands or other loading receptacles it reduces the periods of waiting. With the use of hand-lifting gear these advantages can also be attained at the smaller works. The transport of iron and sand is of special importance in foundry work, as large quantities are concerned. The very conveyance of these materials to the works must be of such a nature as to ensure their smooth passage through the works. The mixing places, for example, must be arranged so as to give a clear view, that is to say, immediately on the unloading of a railway wagon the various grades of pig-iron must be stacked in such a manner as to enable mixing to be effected quickly during the melting operation.

The overhead runway may be regarded as a universal means of transport for foundry work, although travelling cranes cannot be dispensed with in the hand-moulding shops of large foundries. The crane plant, which was formerly very often operated by hand, *e.g.*, jib cranes, can be replaced by electric or compressed-air hoisting gear, as a useful supplementary aid. The band conveyor, the most advantageous arrangement from the practical standpoint, has been unable to secure a permanent footing in foundries.

The simple fact is that technical equipment alone is not the decisive factor in success, but the question of marketing must also be considered. The disadvantages of the band conveyors can be eliminated by the use of gravity roller conveyors.

Metallurgical Contributions to our Knowledge of Cupola-Furnace Processes.

The Paper read by Dr. Osann, jun., at the general meeting dealt with the results obtained in exhaustive investigations carried out on a cupola with the object of discovering the laws to which metallurgical processes are subject, with special reference to the duration of the melt. This was ascertained by measuring the temperature of the pigs dropping down the furnace, when it was found that, in addition to furnace conditions and charge conditions, as well as the hourly melt output, the coke charge had a considerable effect on the melting period, as a high coke charge resulted in a high combustion coke column, above which the iron passing down the furnace melted. Then, on the basis of works tests and individual experiments, a picture of the melting process of grey iron was evolved. The fact that the iron, before it can melt, must first dissolve the graphite, led to the production of "local melts," which appeared almost uniformly distributed in the furnace and then issued from it as "first melts," leaving behind a "melt residue" which was reduced only in the course of further stages in the melting process, at a high temperature. In the remelting of hyper-eutectic iron, the carbon content was invariably reduced to the approximate eutectic content, but in this case also the melting process was of influence. With very short melt periods for the charge, the graphite dissolved more slowly, while, on the other hand, the oxidation of the graphite by the furnace gases was promoted during the melting process. According as the melt period was increased, the graphite dissolved with proportionately greater completeness. Consequently, with moderately long, and long, melt periods, the carbon in the iron and the iron itself were found to be more easily reducible. Owing to the higher reaction capacity, the reactions between the iron and the slag or the slag-producing constituents occurred on a larger scale after the melt. As the works investigations showed, the progress of the melt also reacted on the structure of the cast iron. Nevertheless, even when the melting process proceeded favourably, graphite residues were still present in the iron produced from the ordinary grey pig. By the addition of iron melted from cast scrap, these graphite residues were partly dissolved. This is attributed to the fact that cast scrap—which is generally of an approximately eutectic composition—becomes slightly hypo-eutectic after melting. For the complete elimination of the graphite residues—a requisite condition for high-grade cast iron (without acicular graphite)—the addition of cast scrap is not sufficient. Tests carried out in an electric crucible furnace provided information as to the melting process, while temperature measurements during the melting enabled the graphite-dissolution process to be judged. In the practical application of the results obtained, the chief point to be noted, in foundry practice, was that the melting period of the charge in the actual cupola must be duly considered.

A New High-Grade Pig-Iron for Foundry Purposes.

Prof. Piwowarsky dealt with the question: To what extent does the use of high-grade pig-iron in cupola-furnace working ensure the production of high-grade grey cast iron? With the use of special grades of low-carbon pig-iron such a relationship had been established in practical foundry work during the last few years. With high-carbon pig-iron the presence of fine graphite afforded no certain guarantee as to the fine-graphitic solidification of the remelted product, nor, therefore, as to the mechanical and physical excellence of the resultant cast iron. It was found, for example, that a hematite iron which had solidified, with fine-graphite formation, in the chill mould, when remelted in the cupola furnace did not yield any better product than that obtained from pig-iron cast in sand and solidified with coarse graphite formation. In a further series of experiments carried out with the use of a low-carbon iron which was solidified grey by sand-casting, better results were shown, from the static-mechanical aspect, than with the use of the same type of pig-iron solidified white by chill-casting and "ferritised" by a following heating process, in which graphite separated out. By a quite definite thermal intermediate treatment of the molten pig, in accordance with melt-superheating principles, however, it was possible to produce a high-grade special pig-iron, which retained its valuable properties even after remelting and yielded a high-grade casting. On the basis of systematic melting tests conducted at a large foundry these interactions had been mathematically proved, and it had been demonstrated that cast iron of this kind, even with a total carbon content of 3.5 to 2.6 per cent., still shows a tensile strength of about 26 kg./mm². (16.5 tons per sq. in.). The new special iron, to which the name "Migra-iron" (an abbreviation of micro-graphite) has been given, as an indication of its fine fracture-structure and its favourable content of fine graphite, is produced by the Vereinigte Stahlwerke (United Steelworks), namely, the high-phosphorous type, at Gelsenkirchen-Schalke, and the low-phosphorous quality at Mulheim/Ruhr (Froedrich-Wilhems Hütte).

SECOND DAY.

On Friday, September 4, the forenoon was devoted to a discussion of the position of the market in respect of iron foundries and a discussion on the raw materials markets: pig-iron, scrap iron, coal and coke. In the afternoon the general meeting proper took place, the first part of the proceedings, in which formal matters were dealt with, being private. This was followed by the public meeting, when the Chairman, Baron von Wittgenstein, of Laasphe, welcomed the guests, among whom were the representatives of the leading economic and technical associations. There was loud applause from all present when the Chairman announced the unanimous petition of the Advisory Council that Dr. S. G. Werner, Düsseldorf, who has been President of the Association for 18 years and to whom the Association owed its present importance, be appointed Honorary Chairman. Equally warm applause greeted the motion that honorary membership be conferred upon Herr Schulz, Regierungsbaumeister (government architect), Justushütte, who had been a member of the Association Committee for more than 15 years and President of the Hesse-Nassau branch of the Association for 20 years.

The Director of the Association, Dr. Geilenkirchen, of Düsseldorf, then read the report on the Association's activities and economic position for the year 1930-31. The meeting concluded with an address by Prof. Schmalenbach, Cologne, on "Measures for Promoting the Creation of Capital."

Annual Report and Economic Position.

In his report Dr. Geilenkirchen referred to the centenary of Stein's death, pointing out that that day coincided with the destruction of Stein's work, *i.e.*, the establishment of political and, what is more, of economic autonomy. He described briefly the causes which had led to this event and called attention to the hopeless position of German industry, in which a general decay of both large and small undertakings had set in, a calamity in which, of course, the Ger-

man foundries had not been spared. Since the prosperous year 1927, over 300 iron foundries had closed down, some voluntarily and some perforce. During this period the number of employed foundry workers had fallen to less than half, and as most of the works were running only on a restricted scale with this reduced number of workers, it would, no doubt, be found that employment in the foundries averaged little more than one-third of the normal figure. The position of the foundries during the year under review was governed by the general policy of price reduction, which in their case, owing to the pressure of the economic position and the low degree of employment, had been carried out on a scale far exceeding the price reduction affected in the whole of the German industries, so that scarcely any foundry was able to work without a loss. The unsatisfactory market in engineering castings was closely connected with the decline in orders from the German engineering works for home and abroad. In the past year the business depression had been slightly ameliorated by the Russian orders; the financing of these, however, had proved so difficult for the engineering industry owing, especially, to the July crisis, that many firms were obliged to forgo these orders.

It is to be regretted, the report states, that the B.J.Z., which was intended to finance undertakings in undeveloped countries, should have proved a failure in this case. The Russian business is, moreover, rendered so difficult by exaggerated, sometimes even impossible, demands as to the quality of machine-tool castings, that the German Foundry Employers' Federation felt obliged to submit this question to its chief technical committee, which had stated its views on the matter. The market in engineering castings had further deteriorated of late, owing to the extended use of weldings, in which connection the decisive factor in most cases was probably to be found, not in the better and cheaper production of machines, but rather in the endeavour of the engineering works to provide full employment for their own welding shops and, consequently, to dispense with the purchase of castings from other sources. In this field also, the foundry associations were endeavouring to solve the hitherto unsettled question of the durability of weldings, as compared with steel castings.

The market in hardware and builders' castings was also at a standstill. The demand for the former had fallen off, owing to diminished purchasing power at home and abroad, while to many buyers of ordinary domestic articles the economic question was of less account than the usefulness of the article. As to builders' castings, it could not be denied that the illusion of an excessive demand produced by the building policy of the State had led to a certain overstraining of the output capacity in respect of a number of products.

Price Restoration.

The chief concern of the Association management was to restore the prices of castings to a level which would afford the iron foundries a modest profit, or at least to avert a further fall in prices. Finished builders' and hardware castings were controlled by cartel throughout; in the open market, only merchant pig-iron was still dealt in. Steps were, however, being taken for the control of this product also, and it was hoped that these would lead to a successful issue within a measurable period. In the engineering-castings branch conditions were considerably more difficult. Here the lack of a uniform and generally-recognised graduated price list, which could serve as a basis for price agreements in respect of the various categories of machine castings, was keenly felt. With the price reduction of 6 per cent. as decided upon in January last, although this was to be expressly restricted to those castings which had not fallen in price since 1929, the lack of the list mentioned resulted in very many foundries being compelled by their customers again to reduce even such prices as had already been reduced—in some cases far below the possible reduction figures as established by calculation—under the pressure of the economic conditions. It was now agreed to adopt a carefully-calculated minimum price list, for complicated, moderately difficult and simple castings. This price list, which had taken years to prepare, was intended to serve as basis for the further price-policy. The uniform conditions of sale and delivery—which had proved their value during the past ten years, and had been repeatedly revised in accordance with the changes in economic conditions—were of continued assistance in regulating the trade between the foundries and their customers. At the present time, when cases of insolvency were so numerous, an effectual clause relating to the reservation of property rights would be of special importance, so as to protect the members from loss, at least partially. In view of the high rates of interest the foundries were, of course, unable to grant their customers excessively long credits, and were obliged to insist upon strict adherence to the terms of payment agreed on, more especially as the raw-materials associations, in particular the Pig-Iron Association and the Coal Syndicate, were in a position to enforce even at the present moment their much more stringent terms of payment.

Raw Materials.

In the supply of raw materials the price level of German pig-iron, which is too high as compared with foreign pig-iron, has the effect of increasing the costs. Unfortunately, the price cannot be lowered, as the German blast furnaces, in common with the iron foundries, are burdened by high taxes, wages and welfare contributions. It was solely for the purpose of promoting export trade that customs rebates were granted in respect of the pig-iron contained in the exports. After long negotiations with the Pig-Iron Association, an agreement had been reached in respect of the amount and calculation of these rebates, namely, on a different basis and with due consideration to the interests of both parties. Respecting the technical properties of the pig-iron, an understanding had been arrived at with the Pig-Iron Association as to the dimensions of the pigs and the permissible degree of sand adherence. In contrast to pig-iron prices, scrap-iron prices had fallen even below the pre-war level, thus affording every inducement to use scrap iron freely in the charge. The scrap dealers were leaving no stone unturned in order to obtain permission to export large quantities of cast scrap, so that the foundries would have to pay higher for this important raw material and would be, accordingly, handicapped in the struggle against foreign competition. The keenest resistance must, therefore, be made against such efforts on the part of the scrap dealers. It was particularly regrettable that only recently it had been possible for them, on the basis of export licences for the so-called "foundry waste," to export large quantities of light-castings scrap from West Germany to Belgium, while at the same time the Gussbruch-Einkauf-Gesellschaft (Cast Scrap Purchasing Company) of the German Foundry Owners' Association had been compelled to buy light-castings scrap in England to cover the requirements of the West German works.

The coke supply of the German foundries had presented no difficulties. The coke works had been able to furnish a satisfactory quality of coke, this success being partly due to the large-scale experiments which had been carried out by the Rhenish-Westphalian Coal Syndicate and the German Foundry Owners' Association. The work of the Association in connection with the formulation of uniform testing regulations in respect of moulding sand—new, as well as used—was nearing completion.

Cost of Wages.

Wages—an item which constituted upwards of one-third of the production costs—had not yet been sufficiently reduced to enable the foundries adequately to meet competition abroad. In many cases the wages for piece-work did not as yet appear to be sufficiently adapted to the actual conditions, although the Association had years ago, in the "Rega" portfolios (Refa-Mappen), provided its members with unimpeachable data for determining the hours of labour. Many works, whose unfavourable situation in respect of raw materials had been offset by lower wages, had been deprived of their competitive capacity through the uniform-wages system. It was imperative that something should be done in this direction.

Dr. Geilenkirchen dwelt upon problems of railway tariffs and general foreign-trade and fiscal policy, in which matters the Association, in concurrence with the central economic associations, had represented the interests of its members. In this connection, the speaker touched upon the German-Austrian Customs Union. He concluded with a reference to the external and internal difficulties of a political nature which militated against Germany's economic recovery, and expressed the hope that, nevertheless, the process of reconstruction might be happily accomplished.

Measures for Promoting the Creation of Capital.

In his opening statement, Prof. Schmalenbach indicated, as the primary requirement, the "taking of timely measures," pointing out that the economic policy of the present government, while showing substantial tactical results in combating the difficulties of the moment, was not an adequate policy for dealing with "long-term" matters; really farseeing measures, which alone could heal the sick economic body, had hitherto been conspicuous by their absence.

Despite the knowledge of the economic position, and particularly of the credit system, obtained through circular inquiries and investigations, statistics and observations of the market, the financial crisis in July—a crisis such as had not been experienced in Germany since 1857—had apparently taken completely by surprise the very people who were most concerned in it. The danger had indeed been averted for the time being by immediate measures on the part of the Government, but this method of combating difficulties could not be successfully followed over a long period; it was, moreover, too costly, as well as prejudicial to Germany's credit. The economic outlook indicated further hard times ahead. An economic system founded on an annual increase of more than 500,000 in the population and more than 200,000 additional new homes had to be reorganised in view of the imminent stagnation in the growth of the population and in the number of homes; this great change-over was still only in the initial stages. Such a drastic alteration of the whole national economic system necessitated an entirely different composition and proportioning of the various branches; it altered, fundamentally, the nature of business life; it meant not only a critical time and misery for many, but demanded, above all, a great deal of new capital. The politico-economic measures which were needed, and had been needed long since, might be summed up in the watchword "Kapitalbildung"—creation of capital.

Exceptional Sacrifices Needed.

His practical suggestions (Prof. Schmalenbach continued) would probably not be exactly popular, as they were for the most part in opposition to public opinion and, especially, as they demanded quite exceptional sacrifices. It was no longer a matter of creating capital by small sums; if they were ever to get away from the unhappy economic unrest, 4 to 5 milliards of marks more capital than heretofore must be created annually. A few hundreds of millions was only a drop in the ocean. The creation of capital on so large a scale, however, could only be achieved by quite exceptional efforts and sacrifices.

First of all, much greater saving was necessary in all classes of the population. In addition to much more stringent penal regulations in respect of debtors involved in bankruptcy proceedings, or in proceedings for the arrangement of a composition, who had been spendthrifts or had wantonly neglected to keep themselves posted as to the position of their business, Prof. Schmalenbach recommended most emphatically a transfer of the bulk of the taxes from the capital-producing side to the capital-consumption side. The effect of this would be that the trade-profits taxes would disappear almost completely and the income tax and corporation profits tax dwindle to 10 per cent. In respect of incomes above R.M. 10,000 the Professor emphatically recommended a direct, heavily-progressive expenditure tax—a tax which had formerly been proposed as a "supplementary tax" by the then Finance Minister of the Reich, Herr Erzberger. This tax could be expected to yield good results not only from the financial, but also from the moral standpoint. Such a tax had an educative effect and was at the same time of financial benefit to the State. As, however, the direct expenditure tax was restricted to only a section of the population and so could not yield the necessary proceeds, the people who had a lower expenditure must also contribute to the attainment of the desired goal; they would, moreover, do so all the more willingly if they saw that a beginning was being made with the upper classes on the bulk consumption, however, only the indirect expenditure-taxes had any bearing. This class of tax, as would be seen from the existing consumption-taxes, was indeed only of slight "educative" service in the creation of capital. As only a very few luxury goods were at present affected by the tax, this extension to include a substantially larger number of categories was imperative. As a means of bringing bulk consumption under this tax, Professor Schmalenbach recommended another substantial increase in the turnover-tax, but with a different method of collection and leaving the most vital requirements exempt.

Greater Output Essential.

In addition to increased thrift, a substantial increase in output was necessary. Capital was created not only by saving, but also by labour; this did not always mean merely that extra labour was required, but rather a more productive and more remunerative organisation of the work. Reference was made to the fact that much "price-slashing" was going on abroad owing to Germans competing against Germans. This abuse must be stopped, by politico-economic means. The speaker was aware that he was making a hardly popular suggestion in recommending, for the purpose of promoting output, the institution of compulsory cartels, created through the initiative of the producers concerned. Such compulsory cartels were also urgently needed for purposes connected with the encouragement of export and the rationalisation of industrial working. A state of things where important measures for the improvement and cheapening of production and for the enhancement of export were often wrecked by the opposition of a few individuals simply could not go on. If the cartels had made scarcely any appreciable progress in organisation during the past 50 years, this was due to the absence of a compulsory coalition.

By joint efforts of the individual branches, especially of the finishing industries, the *promotion of export on a grand scale* would be possible. This was necessary, in order that unemployed labour and the unused excess-capacity of the finishing industries should be utilised to the utmost and more capital thereby created. This was also necessary in view of the Reparations policy. Nothing was so likely to enhance the willingness of foreign countries to wipe out the Reparations as intensive promotion of export.

Publications Received.

Light Alloys.—We have received from the Metropolitan-Vickers Electrical Company, Limited, of Trafford Park, Manchester, an advance copy of a 20-page booklet (No. 7999/1) which describes and illustrates a new light alloy with remarkable properties. Designated "M.V.C.," it is a pure alloy of aluminium and silicon, prepared by a new process which has been patented by the company, and it combines to an unusual degree the qualities of strength and ductility, together with high resistance to corrosion and excellent working characteristics both for casting and for subsequent operations.

The production of the alloy is obviously the result of intensive research combined with wide practical experience. The large foundries which are a notable feature of the Metropolitan-Vickers works have for more than thirty years included a large section devoted to casting in aluminium and other non-ferrous metals, while on the research side the company has some of the finest equipment in the world, including special laboratories for metallurgical examination and chemical and mechanical testing.

The joint efforts of the company's foundry and research staff have resulted in the discovery of a new process of what has been known as the "modification" of the alloy. As is well known, aluminium-silicon alloys of eutectic composition, if melted and cast without special treatment, are weak and brittle. The process of modification consists of adding a reagent to the metal in its molten state, and the effect is to produce a fine-grained, close-knit microstructure, with a marked improvement in strength, ductility and other properties. Above all, however, it is shown by the properties of strength and ductility.

The ultimate tensile strength of "M.V.C." alloy is given as 9 to 11 tons per sq. in. when sand cast and 11 to 13 tons when chill cast. The material thus meets the requirements of the B.E.S.A., Admiralty and Air Ministry Specifications for alloys of this class. Indeed, in Admiralty specifications "M.V.C." has the distinction of being specifically mentioned as an acceptable material for British Naval service, in which strength, ductility and resistance to corrosion are most important considerations.

The ductility of the metal, even when cold, is so great that castings of the alloy can be "set" or bent to a considerable extent without risk of damage. It is stated that it is the makers' practice to check this property of "M.V.C." by making from each melt a test-piece of section 1 in. by ¼ in., which must be able to withstand bending on 2-in. radius through an angle of 90 deg. without breaking. The ductility of the alloy is also shown by the fact that it can be rolled, drawn, spun, forged, pressed or stamped, even into quite thin sections. The material so worked is greatly improved in strength and ductility. With regard to other working properties, the new alloy machines easily and can be readily and effectively welded.

The resistance of the alloy to corrosion by sea-water renders it particularly suitable for marine service, and this has already proved one of its most important applications. This feature is also of importance for other than marine service, the metal being capable of taking a high polish and retaining it for a long time.

The Metropolitan-Vickers Electrical Company has for a considerable time used this alloy exclusively for light castings required in its own manufacture. Following on the successful results in this work the company has now extended its production to supply "M.V.C." alloy to users in other industries, primarily in the form of castings from customers' patterns but also, if required, in the form of rolled sheet, drawn rods and tubes, spinnings, pressings or stampings. On account of its lightness "M.V.C." alloy is cheaper than brass, while further savings result from its low cost of machining and handling.

In view of the growing demand for lighter materials in the construction of aeroplanes, motor-cars, ships, etc., and in many other industries, one realises that the new alloy has a wide field of application.

Electric Welding (with which is incorporated "The Bulletin"), Vol. I (New Series), No. 1.—Published by The Quasi-Arc Company, Limited, 11, Grosvenor Gardens, London, S.W.1. It should be understood that this is a house organ, and not, as its name would indicate, a technical journal of the usual type. By this we do not wish to convey that it does not carry matter of a technical character, only that it is primarily designed to help welders more intelligently to use the products of the Quasi-Arc Company. This first issue, being contemporary with the holding of the Shipping, Engineering and Machinery Exhibition at Olympia, is largely devoted to welded ship construction, and a number of authentic articles brings this subject up to date.

There are several excellent points about this publication. There is a selected list of Patents Applications germane to the welding industry; a humorous page, one paragraph from which ought to be credited to our irresponsible colleague "Marksman"; a well-written diary of a trip round the world, and an inset portrait of Faraday. Naturally, new technical developments made by the firm and some gossip about its social and industrial activities are included.

Thermostats.—A large-sized postcard has been utilised by the Drayton Regulator & Instrument Company, Limited, of West Drayton, Middlesex, to describe and price a complete line of thermostats.

Mechanical Properties of Malleable Iron on Various Sized Test-Bars.

(*Continued from page* 179.)

nodules to be deposited as graphite instead of pearlite. The less compact form in which the graphite has been deposited (shown more clearly in Fig. O) appears to make it capable of dissolving more rapidly (as suggested above when discussing Fig. M), since comparing Fig. N with Fig. E the temper-carbon in the former has been removed to a greater depth than in the latter. The pearlite-ferrite round the outside is again in the fine form.

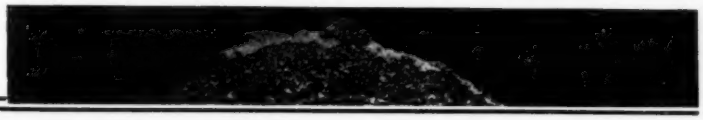
Fig. O. 0.564-in. dia. Whiteheart. One Anneal, containing 0.57 per cent. Manganese. Centre of Bar shown in Fig. N.—The temper-carbon is in a much less compact form than in the 0.08 per cent. manganese whiteheart, and is surrounded by ferrite.[3] The remainder of the matrix is pearlite. Crystals of manganese sulphide are present throughout.

The mechanical tests on the various types of malleable iron which are plotted in Figs. 2 to 25 and tabulated in Table II and III will now be considered.

(*To be concluded.*)

Quantitative Determination of Martensite by X-Rays.—In a Paper entitled "A Quantitative Determination of Martensite and Austenite in Quenched and Tempered Steels by Means of X-ray Analysis," the author, Sinkiti Sekito, comes to the following conclusions:—(1) By tempering quenched steels the alpha martensite completely changes into beta martensite in a range from 100 to 120 deg. (2) Retained austenite is stable up to 200 deg. and afterwards rapidly decreases; at 240 deg. it completely disappears. Very probably in this range of temperature the austenite first changes into beta martensite and soon decomposes into ferrite and cementite.—Science Reports of Tôkohu University.

[3] The graphitising action of graphite is discussed by the author in "Journal of the Iron and Steel Institute," Vol. 119 (I), Page 460.



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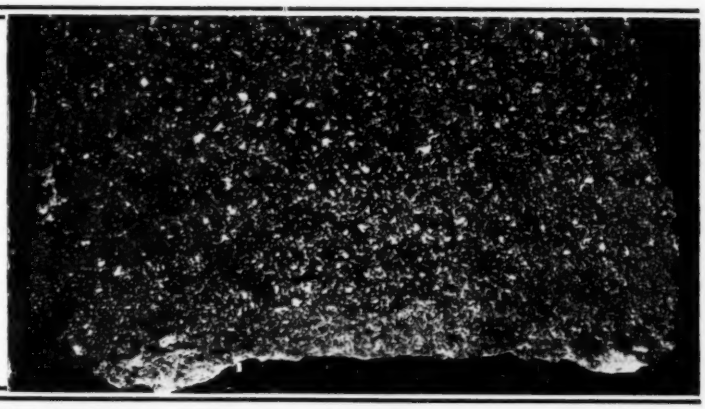

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TRADE SIROCCO MARK

The Shipping, Engineering and Machinery Exhibition.

We have seldom seen an exhibition which is more thoroughly representative of the art of the founder than the 1931 Shipping, Engineering and Machinery Exhibition which opened last Thursday at Olympia. Naturally, marine engineering requires the highest grade of really large grey-iron castings, and excellent examples abound everywhere. Cases are shown, however, where weldings have replaced turbine-engine castings of considerable dimensions. The use of special cast iron is abundantly evident, such as non-growth iron for chain-grate stoker links; alloyed iron for piston rings; irons, with glass-hard surfaces, for wear resistance; stainless castings, and so on. Non-ferrous castings in the form of manganese-bronze propellers, aluminium, both sand- and die-cast parts, and innumerable brass and bronze parts for instrument work.

The importance of the field opened to them by this Exhibition has been realised by concerns which are predominantly foundry owners, and excellent examples of the founder's art are shown by **Fry's Metal Foundries, Limited,** and **R. W. Coan, Limited** (light-alloy and die castings); **The Sheepbridge-Stokes Centrifugal Castings Company** and **British Piston Ring Company** (piston rings and the like); **Duport Foundries** (grey-iron castings of the lighter variety).

Further Treatment of Castings.

For the preparation of castings for the market, this Exhibition is of exceptional interest. For instance, the range of portable grinders, pneumatic chisels and similar tools is prominently shown by **Armstrong Whitworth & Company, Limited, Consolidated Pneumatic Tool Company** and **F. Gilman (B.S.T.), Limited,** whilst lines of single- and double-headed high-speed grinders are seen on the Stands of **Selson Engineering Company, Black & Decker, Limited,** and others. Whilst there is rather a paucity of conveyor exhibits, **Transporting Machinery & Engineering Company, Limited,** have certainly got together an attractive Stand, where, in addition to a chain conveyor in motion, they show a line of electric hoist blocks, with a creep lift specially suitable for withdrawing patterns from moulds. Other lifting tackle, in the form of robust pulley blocks, is being shown by the **Universal System of Machine Moulding & Machinery Company, Limited.**

For the heat-treatment of castings, we were attracted by the excellent display on the Stand of **Wild-Barfield Electric Furnaces, Limited.** Here a furnace is in operation which is fitted with the standard automatic temperature control. Due to recent research on the properties of nickel-chrome alloys, the life of the windings of these furnaces has been considerably enhanced. Other electrically-heated furnaces, some with forced draft of patented design and others carrying pusher apparatus for handling gudgeon pins and the like, are shown in operation.

Testing Machines.

This firm are also showing the Vickers' Diamond hardness-testing machine. Another testing machine that all founders will wish to see in operation is the **Tensometer,** which is located in the gallery. Since it was recently described in our columns, it has been adapted to carry out transverse tests on cast iron and notched-bar tests.

Welding.

We have always regarded this Exhibition as showing the latest developments in welding and welding machinery. Because of their great experience in welding ships, pride of place must be given to the **Quasi-Arc Company,** who have both direct- and alternating-current sets in actual operation on their Stand. Technical exhibits showing mechanical strength and resistance to corrosion abound. Merely to state that **British Oxygen Company, Murex Welding Processes, Limited, G. D. Peters & Company, Limited,** and **Thorn & Hoddle** and a number of others indicates how thoroughly representative of the welding industry this Exhibition is.

Melting Plant and Raw Materials.

What we should call a rolling furnace, but what the exhibitors designate a semi-rotary furnace, is being shown by **Sir W. G. Armstrong Whitworth & Company, Limited.** Of 3½-cwt. capacity, it is hand rocked to facilitate melting and control teeming. Either oil or gas may be used as the fuel. By its side is a connecting-rod die-casting machine. Refined pig-iron, made to the buyers' specifications, is shown broken to exhibit typical fractures. Some grades of this iron carry a tensile strength of 24 tons per sq. in. Yet only some ten years ago we remember at this very Exhibition taking electrically-melted cast-iron test-bars and astounding foundrymen by demonstrating that they broke at 19 tons.

The Bureau of Information on Nickel have some sectioned castings on their Stand, and their representatives are particularly well informed as to the latest developments in alloyed cast iron in general. Recent progress is demonstrated by two 8-ft. nickel cast-iron cylinder liners.

A Stand which attracted us very much was a technical exhibit organised by the **Rubber Growers' Association.** Thereon we found sieves coated with some form of rubber to eliminate wear, a feature which we imagine should find its way into the foundry industry. It struck us that shovels ought to be similarly treated, since sand is a particularly abrasive material. At any rate, the experiment is worth while. There are also excellent examples of coloured rubber-coated castings, which can make competition with articles made from gum products, but research is still required to obtain brighter colours. The competition from these resinous products is well shown by a visit to the Stand of **Bakelite, Limited,** where the major portion of their products is ousting castings from industrial use.

Patternmaking Machinery.

There are two Stands devoted to patternmaking machinery, **Danckaert's Woodworking Machinery, Limited,** and **Dominion Machinery Company, Limited.** Both concerns are showing new designs of universal woodworkers, whilst planers, sanders and other tools are also being shown.

Thin Films in Relation to Corrosion Problems.

(*Continued from page* 174.)

ordinary brass condenser tubes and the new tubes made of brass containing 2 per cent. of aluminium. The extent of the damage at any moment is shown by the potential; a low potential represents exposure of the metal below the film. When the surface of the brass is scratched, the potential at once drops, but if the conditions are favourable to film-repair, it rises again. If, however, there is no repair, and attack develops, the potential remains depressed. The potential movements serve to illustrate how, under suitable conditions, the aluminium brass repairs its own film after scratching, whilst the film on ordinary brass suffers a permanent breakdown. These laboratory curves are in close accord with the good behaviour of the new alloy in service.

(*To be concluded.*)

Personal.

Mr. James Walker, foreman blacksmith at the Motherwell Bridge and Engineering works, has retired from active duty. He received a presentation from his fellow-workmen at a social function held last week.

Trade Talk.

Sweden's embargo on wrought-iron and steel scrap, which expired on September 1, has been extended till February 29, 1932.

The London headquarters of the India Rubber, Gutta Percha & Telegraph Works Company, Limited, have been moved from Cannon Street to Aldwych House, London, W.C.2.

Messrs. Clarke, Chapman & Company, Limited, of Gateshead, have just completed and are delivering six electric winding engines for Soviet Russia. The electrical equipment has been supplied by the General Electric Company, Limited.

Owing to the temporary closing down of certain departments at the Queen's Park Works of the North British Locomotive Company, Limited, a number of men are being transferred to the Hyde Park Works, Springburn, Glasgow.

Westminster Bank, the trustee for the Stanton Ironworks Company, Limited, 4½ per cent. debenture stock, 1931-45, announces that it has acquired sufficient stock to meet sinking-fund requirements for the current year, so that no drawing will be necessary.

The iron and steel works plant being erected at Dagenham for the Ford Motor Company, Limited, when completed, will consist of one blast furnace, 45 coke ovens, and an iron foundry. It is not intended to instal steel-making plant, rolling mills or a steel foundry.

Three of the Wabana iron-ore mines at Bell Island, Newfoundland, have resumed work on a half-time basis for the present, 1,000 men being affected by the decision to resume operations. Shipments of ore for the 1931 season from Wabana mines are expected to reach about 394,500 tons.

It is reported from Nanking that further purchases in Great Britain, amounting to £750,000, by the Chinese Ministry of Railways are to be made this autumn. These will be in addition to the orders for £200,000 worth of railway materials previously announced to be placed in Great Britain before the end of September. The purchases are being made from the Boxer indemnity funds.

A message cabled from Johannesburg states that contracts for 9,500 tons of steel rails have been placed by the South African Railway Board with the Cargo Fleet Iron Company, Limited, the United Steel Companies, Limited, and the Lancashire Steel Corporation, Limited. A further contract for 7,500 tons of rails has been placed with the British Empire Steel Corporation, of Sydney, Nova Scotia.

A newly-formed company, Burn Silent Gears, Limited, Caxton House, Westminster, London, S.W.1, have taken over the British rights of the Burn gear, including those previously held by Stothert & Pitt, Limited, of Bath, and Burn Transmissions, Limited. In co-operation with the well-known firm of engineers, James Howden & Company, Limited, Glasgow, the new company are in a position to manufacture and supply the Burn gear for the numerous applications where a silent, durable drive is specially advantageous.

The 83rd anniversary festival dinner of the Royal Metal Trades' Pension and Benevolent Society is to be held at Grosvenor House, Park Lane, London, W.1, on Tuesday, November 24 next. Sir Ernest W. Petter will be in the chair. Tickets can be obtained from the offices of the Society at 195, Upper Thames Street, London, E.C.4. There are now 276 pensioners on the books of the Society, many of whom have no income except the Government pension and the help given by the Society. The Board of Management point out that it is to the success of the annual festival dinner that they look to ensure provision for the pensioners.

The Aktiebolaget Atlas Diesel, Stockholm, has granted a manufacturing licence for their well-known "Polar" two-cycle airless injection Diesel engines to British Auxiliaries, Limited, Helen Street, Govan, Glasgow. This company, previously known as the Fiat British Auxiliaries, Limited, has now been reconstructed, and backed by several of the most important shipowning interests in this country. The chairman is Sir Fredk. Lewis, Bart., and seats on the board are held by Mr. C. J. Cowan, Viscount Glenapp, Mr. E. W. Harvey, Mr. I. P. R. Napier, M.C., and Mr. J. H. Silley, O.B.E. British Auxiliaries, Limited, will manufacture at their Govan works "British Polar" engines of various types and sizes of solid-injection engines for marine propulsion, marine auxiliary generating, and other marine purposes, and also for land power stations.

XUM

A PLAIN MATTER OF SELF-PROTECTION

Mr. Ramsay Macdonald has said that the political crisis was caused by alarm at THE STEADY DRAIN UPON OUR GOLD RESERVES.

He said that this drain of gold was due to THE EXCESS OF IMPORTS OVER EXPORTS.

Mr. Snowden's efforts to rectify the position include a very regrettable increase in the INCOME TAX.

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Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—The Cleveland market is still very quiet, and stocks continue to accumulate at the works, in spite of the fact that there are only six furnaces in blast producing ordinary foundry iron. Exports have considerably diminished, while an increasing tonnage of foreign pig-iron is being used. In spite of the lack of business, Cleveland ironmasters firmly maintain prices, and, consequently, are being undercut by producers in other areas. Local consumers, in pursuance of their policy of hand-to-mouth buying, continue to take small parcels. There is no change in prices, which are as follow:—No. 1 Cleveland foundry iron, 61s. per ton; No. 3 Cleveland G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d.; and No. 4 forge, 57s. per ton.

Prices in the East Coast hematite market continue to decline, buyers of hematite mixed numbers being of the opinion that 60s. per ton, the new low level, is capable of being further reduced. Hence sales have dropped, as consumers are delaying their purchases in the hope of a further fall in values. On the West Coast the outlook remains unsatisfactory. There may shortly be a temporary revival in local consumption, as indicated by several new contracts recently concluded, and the fact that the Workington steelworks are expected to reopen at the beginning of next week, but it is not expected to be of any permanent value.

LANCASHIRE.—There is little business passing in the Lancashire market, needs for the month being apparently satisfied. It is hoped that the recent Soviet contracts for finished goods placed in this country may shortly stimulate the demand for pig-iron, although little effect has been noticeable as yet. Complaints are being made by ironmakers that the cheapness of scrap metal is seriously prejudicing the sales of the raw material. For delivery to users in the Manchester price zone, Staffordshire, Derbyshire and North-East Coast brands of No. 3 iron remain at 67s. per ton, with Northamptonshire foundry iron at 65s. 6d., Derbyshire forge at 62s., Scottish No. 3 at 86s. to 87s., and West Coast hematite iron at about 80s. 6d. per ton.

MIDLANDS.—Business in pig-iron has been very quiet during the last fortnight, caution being the keynote of the market. There are no indications of any revival in the consumption of the foundries, particularly those engaged in making builders' castings. The latter group especially, will find business scarce, as many housing schemes have been cancelled, in view of the national economy campaign. The large stocks of unsold material at the makers' works are not being reduced, as new business is only of small dimensions. For delivery to Birmingham and Black Country stations, the ironmasters maintain the price of 62s. 6d. for Northants No. 3 and 66s. for Derbyshire, North Staffordshire and Lincolnshire No. 3.

SCOTLAND.—Business in the pig-iron market remains limited, and consumers' needs are easily satisfied from stock. The position of the foundries with regard to orders, leaves much to be desired. The price of No. 3 foundry, f.o.t. furnaces, continues at 69s. 6d. per ton, with No. 1 at 72s. per ton. Continental No. 3 is quoted at 52s., f.o.t. Grangemouth, with Middlesbrough No. 3 at 57s. 6d. at Grangemouth.

Scrap.

The Cleveland scrap-iron market is still stagnant, there being very few buyers on the market. Merchants, however, refuse to alter prices. Cast-iron scrap is still quoted at 40s., and good machinery quality at 42s. per ton. Merchants in the Midlands are unable to find buyers, in spite of the abnormally low prices, or to get orders for deliveries against present contracts. The depression in the local foundry trade continues, with no immediate hope of abatement. Heavy cast-iron machinery scrap in cupola sizes has met with small sales at 45s. to 47s. 6d., delivered, while light cast-iron scrap continues to be quoted at 37s. 6d. per ton, delivered. The South Wales market is still dull, and prices are a matter for individual negotiation. Business is scarce in the Scottish scrap market, and the effect of the Government proposals on industry is anxiously awaited. Cast-iron machinery scrap is quoted at 46s. to 47s. 6d. per ton, and ordinary cast iron, in pieces not exceeding 1 cwt., at 40s. to 41s. 3d.

Metals.

Copper.—Recent events have not had a favourable influence upon the copper market. The American copper statistics for the month of August were published during the week-end. They reveal a decidedly unsatisfactory state of affairs. Refined stocks show an increase over the previous month's figure of 15,500 tons, while the total stocks have risen by some 13,000 tons. The rumours that have been prevalent of a dissolution of the Copper Exporters, Inc., have met with an official denial, which has strengthened the market somewhat. The preliminary conference of producers that was to have been held last week is shrouded in mystery, and the only information is contained in a cable to the effect that an international conference of producers is to be convened early next month. The lack of any official report of the proceedings at last Thursday's meeting is regarded as very unsatisfactory.

Closing quotations:—

Cash.—Thursday, £30 15s. to £30 16s. 3d.; Friday, £30 1s. 3d. to £30 2s. 6d.; Monday, £29 10s. to £29 11s. 3d.; Tuesday, £29 5s. to £29 7s. 6d.; Wednesday, £28 10s. to £28 12s. 6d.

Three Months. — Thursday, £31 10s. to £31 11s. 3d.; Friday, £30 17s. 6d. to £30 18s. 9d.; Monday, £30 7s. 6d. to £30 8s. 9d.; Tuesday, £30 to £30 2s. 6d.; Wednesday, £29 7s. 6d. to £29 10s.

Tin.—The outlook for tin is not very encouraging, there being apparently no hope of any early increase in consumption, and a surplus of stocks far in excess of those calculated for in the restriction schemes. So far, the production of tinplates in the U.S.A. during the current year is the lowest since 1926, while the estimated output of motor cars in North America during 1931 reveals a decrease of one-third on last year's statistics. Last month's figures caused considerable perturbation, especially those which indicated that there was no sharp decrease in Malayan production, as was expected. It was thought that many of the mines would have to shut down this month in order to comply with the quota restrictions, but, so far, only two show any signs of doing so. However, if the present schemes are faithfully carried out, it seems that an increase in values must be inevitable, although the effect of the restriction will possibly not be felt for a long time, owing to the heaviness of present stocks, and the absence of any appreciable demand.

Official closing prices:—

Cash.—Thursday, £115 to £115 2s. 6d.; Friday, £115 5s. to £115 7s. 6d.; Monday, £114 10s. to £114 12s. 6d.; Tuesday, £113 15s. to £113 17s. 6d.; Wednesday, £110 15s. to £111.

Three Months. — Thursday, £117 10s. to £117 12s. 6d.; Friday, £117 15s. to £117 17s. 6d.; Monday, £117 to £117 2s. 6d.; Tuesday, £116 5s. to £116 7s. 6d.; Wednesday, £113 5s. to £113 10s.

Spelter.—The home market has been quiet, some small business being transacted with consumers. The United States statistics were published at the beginning of the week. The stocks for the month again show a reduction, for the fourth month in succession, but there was a disquieting limitation of domestic deliveries. Messrs. Rudolf Wolff & Company say in their review: "Demand on the part of consumers continues quiet in this country, and the same may be said of the Continent, where buyers are hesitant pending a more clearly defined outlook; but no real weakness has supervened, the market still deriving a certain amount of support in the knowledge that output is being severely curtailed in all producing centres."

Daily fluctuations:—

Ordinary.—Thursday, £10 16s. 3d.; Friday, £10 17s. 6d.; Monday, £10 15s.; Tuesday, £10 18s. 9d.; Wednesday, £10 13s. 9d.

Lead.—In spite of the fact that the price of lead has fallen below £11, and that Germany is not on the market, the outlook is decidedly more hopeful. The imports into the United Kingdom during August were easily the lowest for the year. Consumption is being maintained, as there has recently been a considerable amount of near buying indicating that consumers' stocks, which have been running low for some time, are now nearly exhausted.

The week's prices have been:—

Soft Foreign (Prompt).—Thursday, £10 16s. 3d.; Friday, £10 16s. 3d.; Monday, £10 13s. 9d.; Tuesday, £10 12s. 6d.; Wednesday, £10 11s. 3d.

British Ironfounders' Association.

FURTHER MEETINGS BETWEEN IRONFOUNDERS AND MERCHANTS.

The discussions between the ironfounders and merchants engaged in the light castings industry, so successfully initiated in July, were continued last week. As is well known, the purpose of these meetings is to explore the possibility of arriving at a working agreement between manufacturers and distributors, in the hope of placing the industry thereby on a more prosperous and economic basis. It is, therefore, encouraging to note that the most friendly and harmonious spirit has prevailed throughout the deliberations that have taken place. Although certain differences of opinion in regard to points of detail were inevitable, these have been discussed on both sides with a real desire to arrive at a satisfactory arrangement which would be acceptable to all parties. Initial differences speedily disappeared in an atmosphere of reason and compromise, with the result that such progress has now been made that so far as the Conference is concerned, the Agreement in Draft is complete and ready for submission to and consideration by the members of each association likely to be effected.

It was agreed that general meetings for this purpose should be held as soon as possible both by the British Ironfounders' Association and each of the merchants' organisations represented at the Conference. It is to be hoped that in this way final approval may be given at an early date to the draft proposals.

Unanimity Essential.

It cannot, however, be emphasised too strongly that although an agreement on paper may have been completed, there is no intention whatever on either side to attempt to put it into operation until a strength of membership has been obtained particularly on the part of the British Ironfounders' Association. Without this, it is recognised that the agreement would be worthless, inasmuch as it could not be carried out and no real or effective control could be maintained. There is no inclination to see repeated the errors of the past, whereby some manufacturers deliberately took advantage of the fact that an agreement had been entered into, in order to undermine the whole position for their own individual and personal profit.

Both manufacturers and merchants are therefore fully agreed that *nothing less so far as the British Ironfounders' Association is concerned* THAN A HUNDRED PER CENT. MEMBERSHIP OF THE MANUFACTURERS WHO COUNT will suffice if the arrangement is to be given practical effect.

The salient fact still remains that the firms at present outside the B.I.A. hold the key to the situation. When the Draft Agreement has been finally approved by the associations concerned, it is hoped that a further appeal may be made to outside ironfounders for their active co-operation, now that matters have advanced so far, and that they will be prepared to discuss the position afresh and without prejudice to any opinions previously held, bearing in mind that the prosperity of the industry as a whole is at stake and that without their support there can be no agreement, and the great hopes that are based on that agreement will be dashed to the ground.

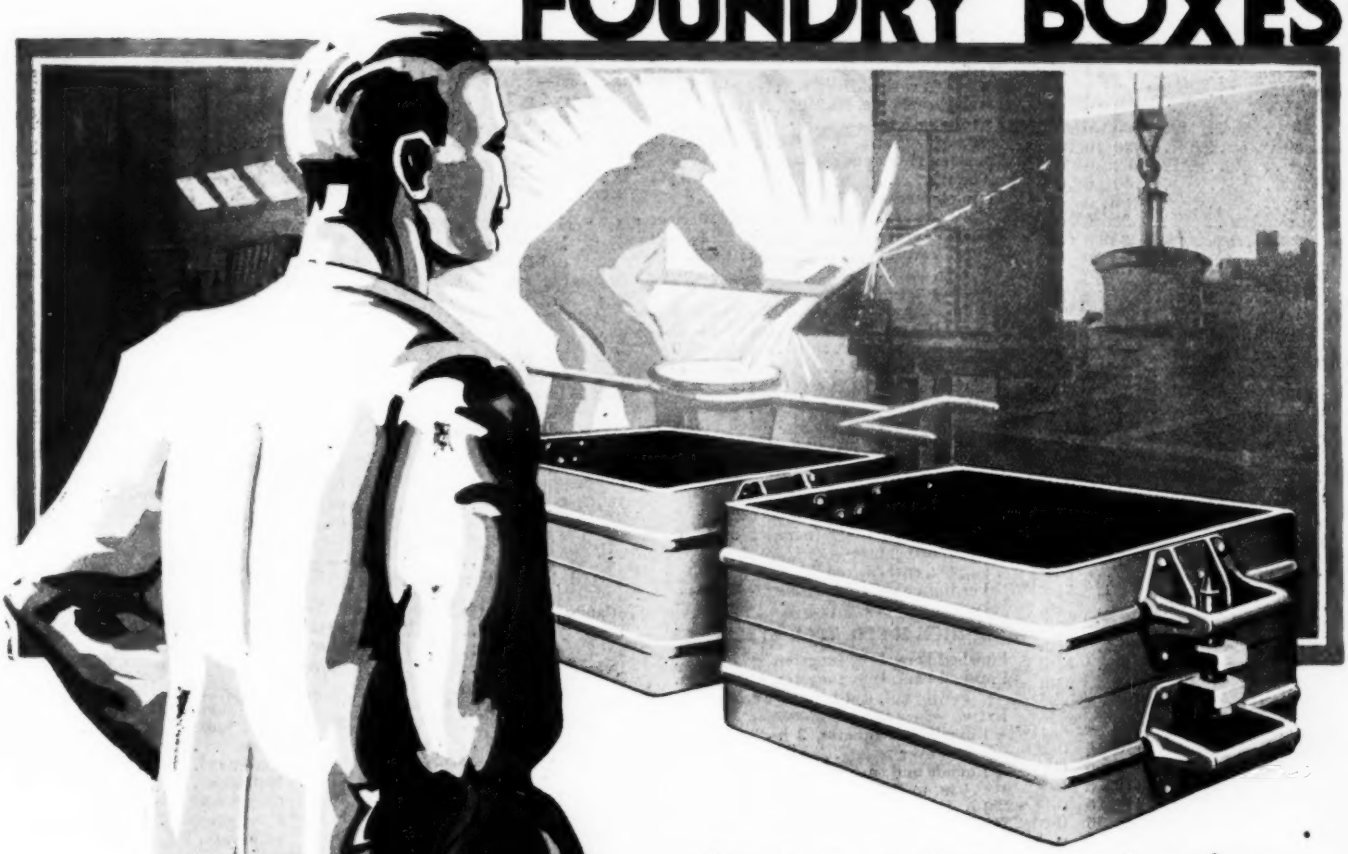
On the other hand, there is no doubt whatever as to the complete sincerity of the merchants and manufacturers engaged in the recent negotiations and of their unanimous determination, if an agreement is brought into working effect, to see that its terms are honourably fulfilled in the letter and the spirit. At all events, the meetings have been of the greatest advantage in clearing away misunderstandings and establishing a real friendly relationship.

The Next Step.

The B.I.A. will be holding its quarterly meeting at York next week, when the Draft Agreement will be submitted to the members, and, it is hoped, will be in substance approved by them. A further meeting of the full Joint Conference to receive the final confirmation of the associations concerned has been arranged to take place in London on October 6. If, therefore, outside manufacturers will in their own interests, and those of the industry as a whole, take a broad view of the position, there is no doubt whatever that the agreement can be brought into effect within a comparatively short space of time, to the immense advantage of the industry. If not, it must be obvious that the only alternative is likely to be unrestricted competition, and a consequent state of affairs in which the trade must inevitably drift from bad to worse. Surely it must be admitted that every manufacturer and merchant has an individual responsibility in assisting to prevent such a disaster.

XUM

FOUNDRY BOXES



...that speed up production for the Modern Foundry—

One of the greatest improvements you can introduce into your foundry is the STERLING ROLLED STEEL MOULDING BOX . . . . the result is speed and economy all round. Your moulders will put down more moulds per day because of the light and easy handling properties of these boxes.

You will be sure of producing accurate castings because STERLING BOXES maintain their accuracy permanently. Also your moulding costs will be halved—STERLING BOXES stand up to heavy service, anywhere.

Sterling

UP-TO-DATE

MOULDING BOX EQUIPMENT

Save their cost in a few months, and are obviously a sound investment for any foundry.

STERLING FOUNDRY SPECIALTIES LTD.

WORKS— BEDFORD.

LONDON OFFICE:— 13, VICTORIA STREET, S.W.1.

Agents at GLASGOW and MANCHESTER

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	28	10	0
Three months	29	7	6
Electrolytic	33	10	0
Tough	30	0	0
Best selected	30	10	0
Sheets	62	0	0
India	40	0	0
Wire bars	36	0	0
Do., November	36	0	0
Do., December	36	0	0
Ingot bars	36	0	0
H.C. wire rods	35	10	0
Off. av. cash, August	32	12	3
Do., 3 mths., August	33	10	0
Do., Sttlmnt., August	32	12	1½
Do., Electro, August	35	19	7½
Do., B.S., August	34	1	3
Do., wire bars, August	36	11	6
Solid drawn tubes			10d.
Brazed tubes			10d.
Wire			6¼d.

BRASS.

Solid drawn tubes	9d.
Brazed tubes	11d.
Rods, drawn	7¼d.
Rods, extd. or rlld.	5d.
Sheets to 10 w.g.	7¾d.
Wire	7¼d.
Rolled metal	6¾d.
Yellow metal rods	4¾d.
Do. 4 × 4 Squares	5¼d.
Do. 4 × 3 Sheets	5¼d.

TIN.

	£	s.	d.
Standard cash	110	15	0
Three months	113	5	0
English	112	5	0
Bars	114	5	0
Straits	112	15	0
Australian	113	0	0
Eastern	116	5	0
Banca	120	5	0
Off. av. cash, August	114	19	1½
Do., 3 mths., August	117	9	4½
Do., Sttlmt., August	114	19	0

SPELTER.

	£	s.	d.
Ordinary	10	13	9
Remelted	10	5	0
Hard	8	5	0
Electro 99.9	13	5	0
English	11	10	0
India	10	10	0
Zinc dust	19	0	0
Zinc ashes	2	10	0
Off. aver., August	11	14	7¾
Aver. spot, August	11	8	9¾

LEAD.

	£	s.	d.
Soft foreign ppt.	10	11	3
English	12	0	0
Off. average, August	11	19	4½
Average spot, August	11	18	10½

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	20	0	0
Do., V.M. ex-whf.	19	5	0
Rods	22	0	0
Boiler plates	14	12	6
Battery plates	16	5	0

ANTIMONY.

	£	s.	d.
Special brand, Eng.	34	0	0
Chinese	22	0	0
Crude	20	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	16	15	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£7 7 6
45/50%	£10 7 6
75%	£15 2 6
Ferro-vanadium—	
35/50%	12/8 lb Va.
Ferro-molybdenum—	
70/75% c. free	4/2 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9½d. lb.
Ferro-phosphorus, 20/25%	£15 10 0
Ferro-tungsten—	
80/85%	1/8½ lb.
Tungsten metal powder—	
98/99%	1/11½ lb.
Ferro-chrome—	
2/4% car.	£27 10 0
4/6% car.	£21 2 6
6/8% car.	£20 10 0
8/10% car.	£19 15 0
Ferro-chrome—	
Max. 2% car.	£29 10 0
Max. 1% car.	£33 12 6
Max. 0.70% car.	£35 10 0
70% carbon-free	9¾d. lb.
Nickel—99% £170 0 0 to £175 0 0	
Ferro-cobalt	8/- lb.
Aluminium 98/99%	£85 0 0
Metallic chromium—	
96/98%	2/7 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £ 9 0 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten 2s. 0d.
Finished bars, 18% tungsten 2s. 9d.
Per lb. net, d/d buyers' works.

Extras—
Rounds and squares, 3 in. and over 4d. lb.
Rounds and squares, under ½ in. to ¼ in. 3d. lb.
Do., under ¼ in. to $\frac{1}{16}$ in. 1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in. 3d. lb.
Do., under ½ in. × ¼ in. 1/- lb.
Bevels of approved sizes and sections 6d. lb.
Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.		£	s.	d.
South Wales							
Heavy steel	1	18	0	to	2	0	0
Bundled steel and shrngs.	1	14	0	to	1	17	6
Mixed iron and steel	1	13	0	to	1	15	0
Heavy cast iron	2	1	0	to	2	2	0
Good machinery for foundries	2	5	0	to	2	7	6
Cleveland—							
Heavy steel			1	17	6		
Steel turnings			1	5	0		
Cast-iron borings			1	2	0		
Heavy forge			2	7	6		
W.I. piling scrap			2	2	6		
Cast-iron scrap	2	0	0	to	2	2	0
Midlands—							
Light cast-iron scrap			1	17	6		
Heavy wrought			2	5	0		
Steel turnings, f.o.r.			0	14	6		
Scotland—							
Heavy steel			1	17	6		
Ordinary cast iron			2	0	0		
Engineers' turnings			1	5	0		
Cast-iron borings			1	10	0		
Wrought-iron piling			2	5	0		
Heavy machinery			2	6	0		

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	24	10	0
Brass	17	0	0
Lead (less usual draft)	8	15	0
Tea lead	5	15	0
Zinc	4	10	0
New aluminium cuttings	51	0	0
Brazier copper	21	10	0
Gunmetal	21	0	0
Hollow pewter	76	0	0
Shaped black pewter	55	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	61/-
Foundry No. 3	58/6
Foundry No. 4	57/6
Forge No. 4	57/-
Hematite No. 1	60/6
Hematite M/Nos.	60/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	72/6
„ d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands—	
Staffs common*	—
„ No. 4 forge*	61/-
„ No. 3 fdry.*	66/-
Shrops basic	—
„ Cold blast, ord.	—
„ „ roll iron	—
Northants forge*	57/6
„ fdry. No. 3*	62/6
„ fdry. No. 1*	65/6
Derbyshire forge*	61/-
„ fdry. No. 3*	66/-
„ fdry. No. 1*	69/-
„ basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	72/-
„ No. 3	69/6
Hem. M/Nos. d/d	68/6
Sheffield (d/d district)—	
Derby forge	58/6
„ fdry. No. 3	63/6
Lincs forge	—
„ fdry. No. 3	63/6
E.C. hematite	75/-
W.C. hematite	81/6
Lancashire (d/d eq. Man.)—	
Derby forge	62/-
„ fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	86/-
Clyde, No. 3	86/-
Monkland, No. 3	86/-
Summerlee, No. 3	86/-
Eglinton, No. 3	86 -
Gartsherrie, No. 3	86/-
Shotts, No. 3	86/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

	£	s.	d.		£	s.	d.
Iron—							
Bars (cr.)	9	15	0	to	10	5	0
Nut and bolt iron	8	5	0	to	8	10	0
Hoops	10	10	0	to	12	0	0
Marked bars (Staffs) f.o.t.					12	0	0
Gas strip	10	10	0	to	12	0	0
Bolts and nuts, ¾ in. × 4 in.					12	5	0
Steel—							
Plates, ship, etc.	8	15	0	to	8	17	6
Boiler plts.	8	17	6	to	9	15	0
Chequer plts.					10	7	6
Angles					8	7	6
Tees					9	7	6
Joists					8	15	0
Rounds and squares, 3 in. to 5½ in.					9	7	6
Rounds under 3 in. to ⅜ in. (Untested)	6	12	6	& up.			
Flats—8 in. wide and over					8	12	6
„ under 8 in. and over 5 in.					8	17	6
Rails, heavy	8	5	0	to	8	10	0
Fishplates					12	0	0
Hoops (Staffs)					9	5	0
Black sheets, 24g.	7	15	0	to	8	5	0
Galv. cor. shts. 24g.	8	17	6	to	9	0	0
Galv. flat sheets	9	7	6	to	9	10	0
Galv. fencing wire, 8g. plain					10	10	0
Billets, soft	4	17	6	to	5	5	0
Billets, hard					6	12	6
Sheet bars	4	12	6	to	4	17	6
Tin bars					4	12	6

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	10½d.
Sheet to 10 w.g.	11¾d.
Wire	11¾d.
Rods	11¼d.
Tubes	1/6d.
Castings	11¾d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
3/- to 10 g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	16.76
No. 2 foundry, Valley	17.00
No. 2 foundry, Birm.	12.00
Basic	17.26
Bessemer	18.76
Malleable	18.76
Grey forge	18.26
Ferro-mang. 80%	85.00
O.-h. rails, h'y, at mill	43.00
Billets	29.00
Sheet bars	29.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	2.09
Steel bars	1.60
Tank plates	1.65
Beams, etc.	1.65
Skelp, grooved steel	1.60
Skelp, sheared steel	1.65
Steel hoops	1.80
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	2.90
Wire nails	1.90
Plain wire	2.20
Barbed wire, galv.	2.55
Tinplates, 100-lb. box	$5.00

COKE (at ovens).

Welsh foundry	22/6 to 25/-
„ furnace	14/- to 15/-
Durham and Northumberland—	
„ foundry	13/- to 14/-
„ furnace	13/-
Midlands, foundry	—
„ furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box	13/- to 13/3	
„	28×20 „	26/-	
„	20×10 „	19/1½	
„	18¾×14 „	14/-	
C.W.	20×14 „	12/3	
„	28×20 „	24/6	
„	20×10 „	18/10½	
„	18¾×14 „	14/-	
Terneplates	28×20	25/6 per box basis f.o.b.	

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0 to £7 0 0
Bars, hammered, basis	£16 10 0 to £17 0 0
Bars and nail-rods, rolled, basis	£15 17 6 to £16 5 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£32 0 0 to £33 0 0
Faggot steel	£18 0 0 to £23 0 0
Bars and rods dead soft, st'l	£10 0 0 to £12 0 0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Current Discounts.

	Tubes.	*Fittings.*
Gas	62½%	57½%
Water ..	58½%	52½%
Steam ..	55%	47½%

W.I. 12½% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Sept.	10 ..	30	15	0	inc.	3/9
,,	11 ..	30	1	3	dec.	13/9
,,	14 ..	29	10	0	,,	11/3
,,	15 ..	29	5	0	,,	5/-
,,	16 ..	28	10	0	,,	15/-

Electrolytic Copper.

		£	s.	d.		
Sept.	10 ..	34	10	0	No change	
,,	11 ..	34	0	0	dec.	10/-
,,	14 ..	33	10	0	,,	10/-
,,	15 ..	33	15	0	inc.	5/-
,,	16 ..	33	10	0	dec.	5/-

Standard Tin (cash).

		£	s.	d.		
Sept.	10 ..	115	0	0	inc.	22/6
,,	11 ..	115	5	0	,,	5/-
,,	14 ..	114	10	0	dec.	15/-
,,	15 ..	113	15	0	,,	15/-
,,	16 ..	110	15	0	,,	60/-

Tin (English ingots).

		£	s.	d.		
Sept.	10 ..	116	10	0	inc.	20/-
,,	11 ..	116	15	0	,,	5/-
,,	14 ..	116	0	0	dec.	15/-
,,	15 ..	115	5	0	,,	15/-
,,	16 ..	112	5	0	,,	60/-

Zinc Sheets (English).

		£	s.	d.		
Sept.	10 ..	20	0	0	No	change
,,	11 ..	20	0	0	,,	,,
,,	14 ..	20	0	0	,,	,,
,,	15 ..	20	0	0	,,	,,
,,	16 ..	20	0	0	,,	,,

Spelter (ordinary).

		£	s.	d.		
Sept.	10 ..	10	16	3	inc.	1/3
,,	11 ..	10	17	6	,,	1/3
,,	14 ..	10	15	0	dec.	2/6
,,	15 ..	10	18	9	inc.	3/9
,,	16 ..	10	13	9	dec.	5/-

Lead (English).

		£	s.	d.		
Sept.	10 ..	12	5	0	No	change
,,	11 ..	12	5	0	,,	,,
,,	14 ..	12	0	0	dec.	5/-
,,	15 ..	12	0	0	No	change
,,	16 ..	12	0	0	,,	,,

Imports and Exports of Iron Castings in August and the eight months 1931, compared with August and the eight months 1930.

	August, 1930.	August, 1931.	Eight months, 1930.	Eight months, 1931.	August, 1930.	August, 1931.	Eight months, 1930.	Eight months, 1931.
Imports.	Tons.	Tons.	Tons.	Tons.	£	£	£	£
Pipes and Fittings, Cast	1,083	1,351	14,173	9,424	12,727	17,333	170,777	119,289
Castings, in the Rough, Iron	220	98	1,633	1,117	3,969	2,169	35,109	22,555
,, ,, ,, Steel	819	552	9,739	4,208	19,522	12,452	229,822	90,633
Hollow-ware, Cast, not Enamelled	2	4	22	56	280	457	2,349	4,016
,, ,, Enamelled	1	3	17	45	90	209	1,019	2,207
Exports.								
BUILDERS' CASTINGS—								
To Argentine Republic	120	70	1,435	615	4,246	4,479	63,123	28,454
,, British South Africa	178	314	1,578	1,523	7,120	8,795	62,120	55,325
,, ,, India	110	165	1,043	954	4,048	7,460	38,472	34,856
,, Australia	5	3	236	63	137	94	13,662	2,882
,, New Zealand	73	21	700	278	4,452	820	41,000	17,547
Total (including other countries)	1,383	1,342	11,790	8,986	61,185	53,849	524,842	395,293
PIPES AND FITTINGS—CAST—								
To Argentine Republic	833	460	10,809	3,995	9,317	4,646	106,749	39,068
,, British South Africa	866	530	5,722	5,700	7,539	5,832	62,708	66,827
,, ,, India	154	270	2,176	1,213	2,515	3,210	33,611	20,023
,, Straits Settlements and Malay States	2,196	224	6,878	2,141	16,475	2,141	58,360	22,768
,, Ceylon	258	3	1,168	498	2,025	60	11,227	6,318
,, Australia	31	8	592	113	625	190	10,883	2,427
Total (including other countries)	11,732	5,238	82,261	50,023	115,090	54,974	905,193	568,303
HOLLOW-WARE—								
Cast, not Enamelled, and Cast, Tinned	256	127	2,722	1,468	9,429	4,265	89,322	50,954
,, Enamelled	52	32	534	349	5,064	3,703	46,850	34,956
CASTINGS, in the rough—								
Iron	210	96	1,660	1,763	7,093	2,929	51,435	38,240
Steel	111	70	1,409	894	5,614	2,107	57,606	30,956

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARK LIMPET

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

ADVERTISER seeks work; last employed for 17 years with firm of motor cylinder and malleable ironfounders, in charge of correspondence and orders inwards and outwards; age 37.—Apply, Box 882, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Manager desires position. Modern experience, could introduce good paying speciality. (London district preferred.) Box 868, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

REAL Foundryman desires position, having been in entire charge of large foundry producing castings for motor and engineering trades in large quantities; 20 years' experience; intricate castings a speciality; 37 years of age.—Box 888, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

NON-FERROUS FOUNDRY, London, S.W. district, requires thoroughly experienced Working Foreman. Production covers practically all classes of work. Equipment absolutely modern and machine moulding a specialty. Capable metal mixer essential.—Detailed particulars of career, age, and remuneration required, to Box 886, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Any Member, Associate Member or Associate of the Institute of British Foundrymen who desires his qualifications to be inserted in the column must forward to the General Secretary of the Institute the following information:—(a) Name and address; (b) name of present employer (or last employer if unemployed); (c) brief particulars of qualifications, experience, and type of position required. The name will not be disclosed until the candidate is in communication with a prospective employer. Announcements will be inserted in two successive issues, unless announcers' requirements have been met with in the meantime.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

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